Aide-Memoire

TO

THE MILITARY SCIENCES.

PART A. B. C.

CONTAINING

SKETCH OF THE SCIENCE AND ART OF WAR.

⁂ The Binder is requested to cancel this page of 'Contents'—the 'List of Plates'—and the 'Notice of the first Part,' on the completion of the Work.

LIST OF PLATES.

NOTICE

OF

THE FIRST PART OF

THE AIDE-MÉMOIRE.

The Editors, in offering the first Part of the 'Aide-Mémoire,' are anxious that the work should correspond, as nearly as practicable, with the Prospectus circulated in May, 1843; but if it is thought otherwise in some respects, it may arise from undue expectations, or from a misconception of the nature of their propositions. They trust, however, that these gratuitous exertions of the Contributors and themselves will be appreciated, taking into consideration the difficulty of giving practical information upon professional points in a very concise form; the Editors having proposed that the 'Aide-Mémoire' should be an abstract of principles, as well as of details, useful to all branches of Her Majesty's and the East India Company's Forces, although with more especial reference to the wants of their own Corps.

The subjects comprise—

The Didactic—for general instruction, of which the 'Sketch of the Science and Art of War' is one, and wherein 'Strategy' and 'Tactics' are anticipated.

The Suggestive—as given in the articles 'Artillery' and 'Battery.'

And Reminders and Matters of Reference—such as Tables, Rules, Formulæ, &c.

This mode of treatment has been chosen to give an interest to the work; and the first Part will serve as an example of the style and

method, which may assist future Contributors to the subsequent Parts.

Any errors or omissions noticed will be inserted hereafter.

The second Part will be probably published at the close of the current year.

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Dublin, 1st May, 1845.

AIDE-MÉMOIRE.

SKETCH OF THE SCIENCE AND ART OF WAR.

BY LIEUT.-COLONEL C. HAMILTON SMITH.

"Hoc illud est præcipue in cognitione rerum salubre ac frugiferum, omnis exempli documenta in illustri posita monumento intueri: inde tibi tuæque reipublicæ, quod imitere, capias: inde fœdum inceptu, fœdum exitu, quod vites."—T. LIVII, *Præfatio.*

WAR, theoretically studied, is found to depend upon demonstrable principles which make it a science, and the adaptation of the principles to practice convert that science into an art. But, although at first sight the theory is sufficiently clear, the great variety of circumstances which must be taken into consideration, and the momentary alterations these present, are causes that of all arts it is the most complicated and uncertain in the application. Hence, to write on the subject authoritatively would require an intellect capable of fully embracing every branch of the science, as well as practical experience in command. No such claims can be advanced for the following pages; the consideration which they may deserve reposing solely on principles laid down in general by established reputations, such as Frederick the Great, Lloyd, Tempelhoff, the Archduke Charles, Jomini, Bülow, Klausewitz, and others; or, as regards the maxims relating to British operations, deriving from the above in the form of more particular adaptations, or historically substantiated by events. But, writing less to inculcate than to remind readers familiar with arms, few proofs and short summaries have been preferred to lengthened unnecessary discussions, for which, besides, there was not space in the work. Recourse, however, has been had chiefly to the article 'War,' published in the Supplement of the sixth edition of the 'Encyclopædia Britannica,' and to the 'Précis de l'Art de la Guerre' by General Jomini,—a work which may still be regarded as the best on the science, although the author, when adverting to questions where the British army and its commanders are concerned, is generally misinformed, uncandid, and biassed: he evinces a feeling still more bitter against the Prussians, and even against his countryman General Warnery; all the more to be regretted, as this want of impartiality detracts from his authority as a scientific soldier.

It should be observed, moreover, that his maxims, data, and inferential reasoning, always emanate from a point of view where armies of 150,000 men or more contend with similar forces on the surface of Europe for the destruction or safety of the greatest empires. These are not ordinary wars, and although the ruling principles must remain the same in all, British forces acting on the Continent, even when they constitute the main strength of an army, still co-operate with allies and with hired auxiliaries, which cause essential modifications in the principles; and the fundamental thought which rules the whole system of its hostility is rarely other than offensively

defensive: directing the blows not to the destruction of the enemy, but to the deprivation of his colonial and commercial resources, and thus obtaining an honorable peace by the restoration of the balance of power in Europe. In this view the sketch here offered is reduced to an abstract form, with a few examples where the questions turn upon great continental operations, in order to afford somewhat more space for those which refer directly to insular expeditions, such as constitute the far greater portion of the military operations of the British army. The experience of preceding wars shews that these undertakings are likewise amenable to general principles completely in harmony with the general maxims; requiring no other proofs than allusion to past events, most of which are known to all studious officers, and therefore are in no want of circumstantial narratives: yet as they have not been subject to much public discussion by competent parties, and on some points valid objections exist against received conclusions, cases are pointed out where armies in alliance with Great Britain might have been saved and positions occupied which would have arrested the progress of the common enemy, if more enlarged views had swayed their resolutions, and more reliance had been placed upon the power that is mistress of the sea. The mere indication of these facts has been deemed sufficient to those, who, understanding war, feel a single word will convey all the other ideas that emanate from them. Where the notices are somewhat more diffuse, they relate to such British operations as seem never to have been investigated upon the principles of military science. It is true that assent and dissent to military reasoning, depends often not so much upon the absolute truth of the principles as on the manner of considering them in different armies: the geographical position and structure of the Austrian and Prussian territories influence the opinions of their schools as much as those of Russia and France under other conditions produce the same effect; and the British, totally different by institutions and insular location, is widely distinct from them all. The value of the aphorisms is therefore narrowed to where they are alike admissible in all, and their importance diminishes as they become more influenced by circumstances.

A British military writer may view the questions involved in the term 'great operations' ('grande tactique' of the French) either as they are based on the general principles of the science, in the light they are viewed by continental strategists, or, narrowing the subject, take it up on the insular position of the empire and the local conditions which result from it. For the one leads to operations of immense armies and objects which menace the very existence of states, while the other contemplates principally defensive measures at home, assistance to an ally abroad, and offensive expeditions to distant countries; mainly depending on the superiority of the Royal Navy, and with land forces in no case amounting to more than 50,000 national troops. Hence, on the continent of Europe, the British land forces seldom form an army, or the majority of an army, though generally they constitute the sinew, or main element of strength in a combined force. The views, moreover, which the Government entertain being almost without exception confined to the conquest or recovery of a province in aid of an ally more than for its own aggrandisement; or, while aiming at the destruction of an enemy's commercial resources, they are directed towards the trading ports or naval stations of an opponent, the maxims which inculcate striking at the vital power of an enemy through his capital are but little appreciated or applauded. These views are a necessary result of the national military system; for Great Britain, with her immense colonies and popular institutions, on the restoration of peace, always reduces the whole armed establishment to a bare sufficiency for garrisons and recruiting; and on the recurrence of hostility with a great power, such as France, is compelled to reinforce her colonial possessions with nearly the whole of the old and well-

trained regiments; trusting to new levies and in part to inexperienced subalterns for the construction of an army for the field. Meantime, the enemy with a great disposable force on land, but inferior at sea, calculates on the restitution or on compensation for the loss of his colonies by assailing a neighbour,—indifferent whether he be an ally of his opponent or a neutral, because the act of invasion will reduce him to be such; possession will give the rights of conquest; and, perhaps, while another continental system is in agitation, full restitution of the lost colonies may be held out as the price of evacuating the unoffending state, and credit demanded for justice and moderation. But if another great continental power is awakened, and takes up arms, it must be supplied with subsidies,—it meets with discomfiture; the war is protracted, and at length a corps more or less strong from England joins the ally, and is mainly instrumental in the restoration of affairs, until peace resumes her sway, and bloodshed, debt, and glory is the unsatisfactory reward.

Since the wars of the French revolution, the altered condition of the political preponderance of the great military monarchies and the increased influence of public opinion may be expected to affect the question of hiring foreign troops for British service or taking allies into pay; and the application of steam to maritime war, which will affect more particularly the tranquillity of the coasts, the security of Ireland and of the Channel islands, are novel questions not to be overlooked in cases of future serious hostilities.*

Although some of these are problems solely depending upon the Cabinet for solution, military officers who may and ought to be consulted, should not be unprepared with opinions duly formed; and from the advanced condition of the science of war on the continent, together with a consideration of the characters who usually compose foreign ministries, British statesmen cannot themselves remain indifferent to the knowledge of at least the fundamental principles which from henceforth all parties are to look to for security at home and success abroad. For Great Britain and Ireland the defensive question alone requires not simply an accidental or momentary attention directed to a solitary point or instant of alarm, but a well-digested system embracing the whole.

These remarks are submitted as mere instances of the fundamental questions whereon the basis of all military reasoning must repose; but war is a condition of existence so absorbent, so vast, so various and difficult, that viewed as a science it can scarcely be handled but in part, and then it still becomes so voluminous that we must be contented in this Paper to notice only its more important considerations, and give definite notions of terms and their application to the best of our abilities and the extent our space will allow.

By Military policy of a state may be understood the habitual views of a Government, regarding its ambition or interests externally directed towards objects to be attained by force, or internally to be guarded by defensive means.

The *Military system of a state* denotes the nature and composition of the forces by sea and land; the militia and reserves; their organization; laws, pay, recruiting, clothing, discipline, instruction, promotion, rewards and punishments; fortifications, fleets, ordnance, equipments, and all other elements required in war.

Military invasion and occupation may occur without hostility, at the desire or by connivance of an ally or a neutral power, claiming the protection or assistance of a

* Since these ideas were first written on the article 'War,' and repeated above, the pamphlet of the Prince de Joinville shews what is the view on the subject in France.

friendly force; or it may be without hostile events, such as a siege or a battle, and thus is not a positive state of *War*.

War is constituted by the actual employment of force, for the purpose of obtaining by arms that which is withheld by similar means: it may be viewed under a variety of modifications.

Thus, war is offensive or defensive; it has for its object the total subversion of the enemy's power, or is confined to reducing it within given bounds. War may be undertaken as a principal, or only as an ally: it then may become one of intervention, or one of opportunity; that is, where a power at first neutral takes up the cause of one party, and thereby produces a preponderance with a benefit to all the allies, or to itself in particular, for which it has been waiting a fit conjunction of political affairs. In all these cases the mode of enforcing the first great principle of war requires corresponding modifications, so as to adapt the means to the end proposed.

There are wars of opinion and religious wars, for which scarcely any rules can be offered, excepting patience, the exercise of humanity, and rectification of real grievances; but these belong not to military science, and do not therefore concern our present purpose.

War, theoretically viewed, should be waged, according to Jomini, in conformity with one great fundamental maxim, which, rightly applied, renders all combinations appropriate, and, when misapplied, faulty. This governing principle is "*to effect with the greatest mass of forces a combined operation upon the decisive point.*" This decisive point in war, also termed "*the primitive objective point,*" is that wherein resides the principle of the hostile strength, or what has been called the vitality of the Government. To dislocate this power in the shortest and most effectual manner is clearly the fundamental principle for the assailant; and as clearly to avert it by breaking his measures, must be the object of the defendant. But as the aim of belligerents is commonly of a much less decisive nature, the principle remains then most applicable, but still the same, to minor objects.

A British expedition necessarily acts offensively; the commander, fully instructed in the nature of the operations that are entrusted to him, and familiar with the theatre of war, so far as the best maps, &c., can supply information, has already, in concert with the Government, selected the point intended to form the basis of his operations; which, nevertheless, may greatly vary, from political and nautical, as well as considerations of allied co-operation. The choice of a basis always, either on a hostile or a friendly frontier, determines the sphere, or what is termed the ZONE OF OPERATIONS: it is from thence the commander of the forces selects the objective point which he is to aim at, and the line of operations leading to it; and that line may be either temporary or definitive.

Continental armies operate precisely in the same manner, but with more certain facility, because the basis of their operations is on their own territory, unopposed by distance, sea, and winds, for progress or retreat. Their artillery trains, commissariat, and baggage have their equipments; their cavalry is mounted, and subsistence secure; while a force disembarked from sea is without horses, and always obliged to sacrifice invaluable time before it can move, even in a friendly country.

The army marching upon its line of operations is in possession of a front of operations, or a strategical front, in rear of which it is advisable to fix a point of *appui*, or support; that is, a fortress or locality on the line in question to resort to in case of necessity. The momentary positions which the corps of the army may occupy on the front of operations, or on the line of defence, are strategical positions. When the army is within reach of the first objective point, or when the enemy commences

1st Branch. STRATEGICS.

to oppose its progress, the commander-in-chief either attacks him or manœuvres to compel him to retreat. In this view he may select one or two strategical manœuvring lines of a temporary nature, and as such they may deviate to some distance from the intermediate posts, from which they are perfectly distinct. To connect the front of operations with the basis, a staple line, &c., will be formed, to subsist parties and convoys at certain places in their daily marches from and to the army, extending it by degrees as the forces proceed further; and more considerable dépôts of provisions will be made on the commissariat lines to subsist the main body. If the line of operations deepens in length from its basis, and hostile corps threaten to interrupt it, then there will be the option either of attacking and expelling the enemy's detachments, or of pursuing the main object against the army, without regard to these secondary corps. But if it is determined to keep it in check by means of a detachment posted in observation, a double front is produced, and great detachments always cripple the army.

When the objective point is neared, and the enemy resolutely maintains his ground, a battle must be the consequence: should the result be indecisive, a second attack must be made; and, when victorious, the ensuing measures should extend beyond the objective point first aimed at, and endeavour to pass beyond it by fixing upon a second ulterior object. If the capture of an important fortress is the aim, while the siege is undertaken, the coercing army should proceed to drive the enemy far off; or, if it be not sufficiently strong after the besieging corps is formed to push forward, a strategical position should be selected to cover the siege, such as the French, under Bonaparte, adopted in 1796 to cover the siege of Mantua, or it should operate as Marlborough did during the siege of Lisle.

But where there is no siege, or the army is in force sufficient to carry on operations to a second point, it will become requisite to form a point of *appui*, and to construct an Eventual Basis, by occupying one or more towns sufficiently fortified to be safe from insult; or a small strategical reserve should be formed to cover the rear, to protect convoys and the greater dépôts by means of field-works. Should rivers of considerable breadth intervene, *têtes de pont* should be raised to cover them; and if the bridges occur at walled towns, some additional works should be constructed to protect them. These are requisite both to strengthen these posts and add to the solidity of the Eventual Basis where the strategical reserve may be posted.

But should a battle be lost, retreat must ensue towards the basis of operations, in order to collect reinforcements and detachments, replace the deficient materials, and reorganize the elements of combat in fortified towns or intrenched camps, so as to arrest the enemy's progress or compel him to divide his forces.

When winter approaches, the army is placed in cantonments, unless the operations are continued by one of the opposing armies; namely, that which having obtained a decided superiority, finds no insuperable obstacles on the hostile line of defence, and is therefore resolved to make the most of its ascendancy: then a winter campaign is produced, always equally distressing to both armies; but demanding no particular dispositions excepting redoubled activity in the enterprises, in order to arrive the sooner at the desired results.

Such is an abstract view of War as a Theory, and is sufficient to shew the different combinations which the operations produce. They are divisible into three branches.

I. Strategics: a term to which it has been vainly endeavoured to affix a strict definition from the times of Folard, Derelinque in MSS.,* Bülow, and Von Gross,

* Derelinque, 'Tactique des Batailles de l'Impulsion,' &c. Manuscript, four vols. folio, with an immense number of plans, in my possession.—C. H. S.

to Klausewitz, Dufour, and Jomini, whose earlier works and last Précis give the most comprehensive as well as the most satisfactory definition; although a dialectician might hint that a distinction might be pointed out between Strategics and Strategy, or *Strategique* and Strategie; but no inconvenience seems to have arisen from the promiscuous use of both. Jomini's definition embraces under the word 'Strategie'—

1. The definition of the theatre of war, and the different combinations it may offer.
2. The choice and establishment of the Fixed Basis, and Zone of Operations.
3. The determination of the Objective Point to be attained, whether it be offensive or defensive.
4. The determination of the Decisive Points of the theatre of war.
5. The Fronts of Operations and Defensive Lines.
6. Selection of the best Lines of Operations leading from the base to the objective point, or to the front of operations.
7. Selection of the best Strategical Lines for a given operation; the different manœuvres for embracing these lines in all their combinations.
8. The Basis of Eventual Operations, and Strategical Reserves.
9. The manœuvring marches of the army.
10. The magazines considered in relation to the marches of the army.
11. Fortresses considered as strategical means; as places of refuge for an army; as obstacles in the way, or as requiring sieges and covering armies.
12. Intrenched camps, têtes de pont, &c.
13. Diversions and great detachments.

In the several objects enumerated, those which enter chiefly in the sketch or general plan of a campaign, regarded as cabinet and head-quarter questions, have been named. The art of making war upon a map might be appropriately distinguished by the comprehensive designation of STRATEGICS; while all those which are strategical in their direction, and tactical in the execution, such as landings, march manœuvres, passage of rivers, retreats, winter-quarters, ambuscades, and convoys, might take the denomination of STRATEGY, so long as they are executed without the presence of an enemy prepared for resistance; for then they become Tactics.

The first therefore (Strategics) is *the art of embracing the lines of operations in the most advantageous manner;* the second (Strategy), *the art of moving forces in the most efficient manner upon the primitive or accidental lines of operations.*

2nd Branch. TACTICS.

II. The second branch is denominated Tactics, and consists of the manœuvres of an army for action and in action, together with the several formations of troops for attack and defence; in both cases requiring simultaneous combination on the most important points of a field of battle, or the directing the mass of offensive elements on the weakest part of a position or fortress (as in sieges), offensively or defensively.

Thus Grand Tactics embrace more especially:

1. The choice of positions and defensive lines of battle.
2. Offensive defence in action.
3. Different orders of battle, or great manœuvres for attacking an hostile line.
4. Meeting an enemy's army on the march, or unforeseen battle.
5. Surprises of armies in the field, not in winter-quarters.
6. Dispositions for an attack.
7. The Attack of positions and intrenched camps.
8. Coups de main; Escalades.

British forces, generally less numerous, might join to the above—

9. Debarcations in the presence of an enemy.
10. Re-embarcations in the presence of an enemy.
11. Actions with the advanced or rear guards.

But conflicts on the outposts, convoys, foragings, and war detachments, belong to what is termed *Petite Guerre.*

3rd Branch. LOGISTICS.

III. To these Jomini adds La Logistique, or the practical art of moving troops, the detail of marches and formations, the location of encampments and cantonments; in short, the execution of the combinations of Strategy and Tactics. These three branches are more or less interwoven, and, of course, are further connected with Elementary Tactics, the basis of all military order and system.

STRATEGICS. Fundamental Maxim of War.

The definition already given, namely, *effecting with the greatest mass of forces a combined operation upon the decisive point,* and modifications thereof, are good when they are in conformity with the following maxims:

1. To convey by strategical combinations the mass of forces successively on the decisive points of a theatre of war; and as much as possible, on the communications of the enemy without exposing its own.
2. To manœuvre so as to impel this mass upon fractions of the hostile army.
3. On the day of battle to direct by tactical means the same superior mass upon the decisive point of the field of action, or on that part of the enemy's line which it is of most importance to crush.
4. To produce the masses not passively on the decisive point, but in active operation, effecting the object aimed at by simultaneous effort.

An objection has been raised to these maxims, upon the plea that the art consisted precisely in clearly distinguishing decisive points. Their definition will be given in the sequel, and the studious soldier who meditates upon the contents, will rarely mistake them; for a theatre of operations never offers more than three zones, one on the right, another on the left, and a third in the centre; so also each zone, each front of operations, each strategical position and line of defence, like each tactical line of battle, has never more than these same subdivisions, or two extremities of a centre. Of these, one only can be best for reaching the mark aimed at; a second will be less advisable; and a third actually vicious. Therefore, combining the enemy's positions with the geographical points, with consideration of the zone of operations, and with the projects to be effected, all questions of strategical movement and tactical manœuvre resolve themselves into the knowledge whether the operation should be carried on by the right, the left, or by the centre directly to the front,—surely not a difficult problem. Yet, though the whole art of war does not consist solely in the choice of a proper direction for the mass of forces, in that, nevertheless, resides the fundamental maxim of strategics; for there still remains the necessary talent to execute, the knowledge, energy, and coup d'œil for carrying out what proper combinations have prepared. The study of all past wars, ancient and modern, the systems of war of Frederick the Great, of the French revolution, of Napoleon, and, finally, of the Duke of Wellington, will all be found to have derived their success and glory by conducting the armies in harmony with these principles; and the loss of battles, failures in campaigns and entire wars, will be seen to originate in the non-observance of them, either through the prejudices raised by ignorance or routine, political interference, or unavoidable geographical causes.

Plan of a Campaign.

The plan of a campaign depends upon six essential considerations. 1. The political situation of both parties. 2. The situation of the moment. 3. The relative force and military means. 4. The location and distribution of the armies. 5. The natural line of operations. 6. The most advantageous line of operations. It is not required on this occasion to be carefully balancing the exact amount of the relative means of war between the parties, but to admit them only as far as they are important. Territorial and Manœuvring Lines of Operation are the principal objects; and though they are subject to many accessory considerations, the rules of the art must, nevertheless, form their basis. Originality and great boldness are not incompatible with their application; such, for instance, as the plan which in 1800 Napoleon and Moreau carried into effect,—"moving on the flanks of the Swiss mountains on two internal lines; the latter, upon the Austrian external line in Germany, and the former, similarly, but still more originally, upon the flank and rear of Melas, in Lombardy. Never was the great principle above noticed exemplified with more originality or daring; no operations were ever more rich in great and decisive combinations, or more prudent and cautious in the execution; since, while they menaced and effected the enemy's ruin, neither, in case of reverse, would sacrifice more than perhaps the rear guard."—*Jomini.*

In this place it may be useful to fix, by definitions, several terms, upon the comprehension of which the understanding of most important military reasoning depends.

By a *Base* (or *Basis*) of Operations is meant a frontier,—the course of a river,—a coast,—a range of mountains or fortresses,—or any topographical or military extent of country, upon the imaginary line of which the corps of an army assemble: offensively,—to take their departure from thence into the enemy's country, and towards which, in case of failure, it is intended to retreat: defensively,—to counteract all the measures which an invading force may attempt.

Lines of Operation are divided into *Territorial* and *Manœuvring Lines.* By *territorial lines* are understood those which nature or art has traced for the defence or invasion of states. Frontiers covered by fortresses, or defended by nature with chains of mountains, great rivers or other obstacles, are of this nature.

Manœuvring Lines are the movements of the General to traverse the territorial lines offensively or cover them defensively. Both these lines are intimately connected. In offensive war the line is an imaginary perpendicular upon the base, along which an army operates against the enemy. In defensive war it is often the same, but still oftener parallel to the territorial line.

A Line of Communication is either the same as that of operations, or any other by which the army supplies and communicates with the base.

Examples will make the definitions more intelligible: Austria and France have three great lines of operations against each other; by Italy on the south, Switzerland and the Tyrol in the centre, and by Germany on the north. But politically and geographically considered, these are now all closed, because the states of Baden and Wurtemberg interpose between them in Germany; Switzerland is independent in the centre; and the kingdom of Sardinia closes up Italy. Between Prussia and Austria there are similarly three lines, through Moravia, Lusatia, and Saxony.

The *Theatre of Operations* embraces the whole surface of the country which an army, or armies in co-operation, may have to invade or to defend. If a single army has a prescribed end in view, its strategical field extends no further; but, if the combinations of two or more armies are in concert, and directed, beyond the first proceedings, to arrive at an ulterior object in conjunction, then each army operates only upon a zone of the field. Thus a *Zone of Operations* contains the particular

lines which an army acting in concert with others has to traverse to an ulterior object; and a *strategical field* or chess table (*échiquier général*) comprehends the whole theatre of war from the single or double basis of one or more armies, to the ultimate object, usually the enemy's capital. Hence, two belligerents have each, 1, a fixed base of operations; 2, an objective point; 3, fronts of operations and lines of defence; 4, zones and lines of operation; 5, strategical lines and lines of communication; 6, natural and artificial obstacles to surmount or to oppose to the enemy; 7, important strategical geographical points to occupy offensively, or cover defensively; 8, accidental and intermediate bases of operations between the objective aim and the fixed base; 9, points of refuge in case of a reverse.

OFFENSIVE OPERATIONS.

An army which commences offensive operations where no sea intervenes, takes the lead in all the movements, and those opposed to it are necessarily subordinate to them. If, therefore, it occupies with a corps each of the great avenues leading to the enemy, he will be kept in suspense, unless his own forces are sufficient to anticipate the opponents by making the first move, and to assume the offensive defensive. Therefore,

1. When an army invades or acts offensively, it takes the lead (*l'initiative*) in the movements.
2. This advantage precludes the necessity of marching in mass, unless the enemy is concentrated and at hand.
3. The general direction can be only upon the centre, one of the extremities, or the rear of the hostile line. An extremity is usually most eligible, because nearer to the hostile rear; on the centre it is safe only when the opponent's line is still scattered.
4. In this case Jomini recommends the greater number of corps to advance upon one of the isolated parts, with a view to surround it, while the remainder occupy a central point to keep the rest of the hostile army in check.
5. When the principal mass of these corps is directed into the rear of an enemy, by passing one of the extremities of his line, one corps should remain posted upon that extremity, in order to keep open the line of communications, while the opponent is cut off from his. This corps serves likewise to attack his flank and prevent his withdrawing from a faulty position by a secret movement.

Both these last rules evidently apply only where the assailant has a considerable superiority; for in cases where the forces are nearly balanced, he that turns an enemy's flank is exposed to the same manœuvre; and a single corps left to mask the extremity of an hostile line, is less capable of ~~in measure to~~ being reinforced than the enemy, and therefore liable to be defeated, and the whole assailing manœuvre exposed to be counteracted ~~inclosed~~, unless topographical circumstances are more than ordinarily favourable. Thus the celebrated march over the Alps, by means of which Bonaparte, in 1800, turned the whole line of operations of Melas in Italy, would have been counterchecked had there not been a misunderstanding among the Allies. Sir Charles Stuart, with 10,000 British, was before Genoa, and offered to take charge of the position; but the Austrians, eager to grasp at the possession of all Lombardy and the Genoese territory, declined the proposal, in their turn requesting the British to disembark and join their army, for an Austrian, not an allied purpose. Jomini, it is true, aware of the danger such operations incur, elsewhere confines them to no greater length than two or three marches, and does not admit the corps to be separated from each other, further than the outposts are from their corps.

In these rules none occur directly calculated for the plan of a campaign operating from a coast or an insular basis. Great Britain in continental warfare has three fronts or fixed basal lines, by which the army under cover of the fleet may proceed to

OFFENSIVE OPERATIONS.

act offensively on a foreign coast: the Eastern, from Yarmouth to the Downs: the Central, from the Downs and Portsmouth to Southampton: and the right or Western, from Southampton to Plymouth and Cork. There are, however, many difficulties in the application of masses upon the secondary base abroad, especially if that base must be obtained by force on an hostile coast, because the line of communication from the sea-ports at the fixed base whence the army has departed to the point of debarcation is lengthened, and, by reason of the intervention of the elements, liable to be broken: still, the examples of the landing at Aboukir Bay, Copenhagen, the Mondego in Portugal, the Helder and Walcheren, all in the face of the enemy, prove the practicability even when opposed on the spot. The point of debarcation is then the Eventual Basis; and unless a friendly fortress, or one that can be compelled to submit by summary means, or a naturally advantageous position can be occupied or immediately forced, the difficulties are almost insurmountable. It is, again, difficult to despatch a large force in one fleet, and to keep it together, and dangerous to allow great intervals; the elements affect the time, connection, and order of convoys: an independent and separate service (the navy) influences the primary organization: a distinct etiquette may intervene in the moment of execution: debarcation, not so much of the troops, as of their resources, artillery, horses, provisions, &c., require much of invaluable time, and a change of wind may defeat or endanger the whole measure. While a great Captain is at the head of the Army and of the Cabinet, only that which human prudence cannot control will be left to chance; but there have been periods when military experience was not sufficiently appreciated in war measures; and civilians directed them without being even aware that war is an exceedingly complicated science, and that one great error in the plan of operations is sure to end in failure. Yet more than two centuries ago Sir Walter Raleigh said, "the wisdom of princes and of states is best determined in their enterprises."

From the difficulties above stated, a practice has arisen of fitting out expeditions, not sufficiently formidable, with a view of ascertaining the practicability of a measure, but which by that very system is often rendered abortive; for a first landing having been effected, the enemy's attention is no longer divided; he collects his means of defence, while the second convoy is expected, and the delay is decisive of the event. Yet, if in any military operation the effect of masses simultaneously employed be of consequence, it is in those which commence on the sea shore; for the troops have not only to debark and act offensively, but also to construct their means of security and retreat in case of disaster. If we examine the primary operations of this class from the wars of King William to the present period, we shall find, that with the exception of such as were favoured by circumstances, the success or failure was dependent upon one or more of the following maxims, especially as applied to continental expeditions.

1. When an army is embarked to make a descent upon an enemy's coast with the object of penetrating into the country, a point of debarcation should be selected where the enemy possesses no local means of arresting the descent and preventing the landing of a sufficient supply of those means which are indispensable for action and for progress. If therefore a defensible peninsula can be selected, or better, a fortified town accessible for the cannon of the covering squadron, to compel it into an immediate submission, a footing will be gained to form the first point of the Eventual Basis of operations. Still the consideration whether such a point is favourable to the ulterior objects of the expedition should be kept in view. A secure anchorage is necessary for some time either on the spot or in the immediate vicinity, and within the sphere of action of the land force.

2. If the expedition be intended to operate only on the coast with momentary objects, proximity to the objective point should be combined with a locality convenient for re-embarcation. Armed steamers and gun-boats will, in general, secure this object within estuaries, in defiance of a superior enemy on shore. But small expeditions are fit only to distract the enemy's attention, and for that object demonstrations without landing will generally answer all the purposes of descents. Raleigh justly says, "*All petty attempts are more profitable to the invaded than the invader.*"

3. An expedition intended to operate ulteriorly, should be from the first superior to the probable immediate force of the enemy, so that the landing be effected with more decisive success, and the ulterior movements may proceed without delay.

4. No combinations of invasion should be made to depend on the co-operation of corps expected from distant or opposite quarters. It is important to embark them en masse, or, commencing at the more distant part, collect them in passing, or form a rendezvous at an intermediate point, so as to proceed at last with the whole in connection. For instance, if the season is favourable, a rendezvous off Cork, Bantry Bay, or some island in the Bay of Biscay, when the expedition is really intended for the north or west coast of Spain or Gibraltar, or for the Mediterranean, would tend to keep the enemy in suspense.

5. After the landing is securely effected with the view of striking a blow in the interior, it is best to waste no time in besieging any place not directly in the line of operations: let them be masked by a corps on shore, and blockaded by the fleet; or if the line-of-battle ships can attack a front of defence, they will reduce the fortress in a few hours.

6. In the plan of an expedition no combination should be admitted including or depending upon two or more lines of operation from separate bases. Armies transported by sea are, from that circumstance, not numerous: division renders them still weaker, and if one corps is checked, the other must retreat also. It is exposing two exterior lines to one internal line.

7. In colonial and insular expeditions it is only necessary to combine means in proportion to the strength of the objective point, and with attention to the season, climate, monsoon, or trade-winds.

8. An army withdrawing from a territory through another which it is resolved should be kept in subjection or mastered, the occupation should take place at the moment when the greatest mass of forces is passing through or near the most important points.

9. When negociating at the head of an armed force with the chance of resistance, it is important that all the corps be collected to give weight to the demands, and to act instantly when hostilities become inevitable, rather than call for reinforcements when they are begun, and risk to be defeated from absolute inferiority.

10. In offensive extra European wars it is particularly false economy to employ insufficient means against an enemy, to undervalue his resistance, or to aim at indecisive objects. If such measures cause no absolute failure, they at least prolong the contest; the waste of life and expense, and are a source of greater risk than should be incurred, and of less advantage in negociation.*

* The Saxon Colonel Von Gross (Kriegs Geschichte der Jahre 1792 bis 1808) enumerates on the subject of our marine expeditions several others to be requisite, such as:—1. Seasonable period; 2. Thorough knowledge of the country; 3. Intelligence in the country; 4. Dominion of the sea;

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None of these rules should be so modified as to be opposed to the great maxims of war; nor should operations of any kind be undertaken without regard to the class of troops to be employed.

As examples of the importance of the first rule may be quoted, the landing of the emigrants at Quiberon; for if they had not been betrayed by their own men, they still, through supineness, were blocked in and unable to débouche in the face of the enemy. Again, the Helder expedition in 1799, though victorious in two battles, could not advance to the objective point, because through former misdirection of the forces, the enemy, retiring to the narrows of the Haerlemmer Meer, had a position which could not be forced nor turned. On the other hand, at Aboukir in Egypt, a peninsula, the landing was on a central point, which placed the enemy's defensive measures on two external lines, one covering Alexandria and the other Rosetta and Cairo: thus divided, although numerically the strongest, he was inferior on both lines, and ultimately forced to surrender. The landing at the point of Mondego, in Portugal, though again divided by a subsequent force coming on shore at Peniche, shewed a still more advantageous selection, for the enemy could not oppose it, nor attack Sir Arthur Wellesley, until all his troops and cannon were already moving offensively: the debarcation cut off the north of Portugal from Lisbon, and the hostile army from its line of communication with France; and if the re-inforcement under Sir John Moore, that came after the battle of Vimiera, had been sent from the first with the army, Junot must have surrendered at discretion, instead of obtaining a capitulation that sent his army back to France.

In the second maxim, the causes are pointed out which afforded in 1758 a secure retreat from the landing at Cherbourg, although no regular precautions insured the measure; and those which produced the disaster at St. Cast, notwithstanding all the care General Bligh applied to the re-embarcation. The expedition to Ostend had the same defects, and produced the same results; but, with moderate weather, the naval armaments, as now organized, render such operations much more secure.

Inattention to the third rule, had preponderating influence at the Helder. The first division on shore was paralyzed behind the defences on the Zyp until the main body arrived. Meantime the enemy, now certain of the point threatened, collected his means, and, as before stated, rendered victories so unavailing that re-embarcation was purchased by heavy sacrifice.

The expedition to the Helder furnishes the proofs of the fourth maxim. Had the two British corps and the Russian been combined to act simultaneously en masse from the beginning, no effectual resistance could have been made against them; but easterly winds were to convey the Russians westward, and westerly the British eastward, though both were destined for the same point at the same moment. So again, the Egyptian expedition was to be sustained by a corps from India and another from the Cape. At Copenhagen the two British corps united in proper time, because that which was anteriorly in the Baltic lay waiting in transports at Rugen; but the successive divisions sent to the River Plate served only to be successively defeated.

The fifth maxim is exemplified in the Walcheren expedition.

The sixth maxim is obvious. Sir John Moore's expedition was on the coast of Portugal when the battle of Vimiera was fought, where it should have been present, for a corps on board ship cannot aid one on shore, and, if that is defeated, the other must retire also. In the next campaign, Sir John, by several lines from Portugal, and Sir David Baird from Corunna, moved by two zones of operations, with a view

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5. Vicinity of the points of debarcation; and ending with the recommendation of measures to keep up and increase the good-will of the people.

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of uniting their forces at a point more than 200 miles distant, then in the possession of a formidable and manœuvring enemy, though there was an unbroken Spanish corps intermediate which should have been brought into line, and a battle risked on the best available position at the forking of the road to Vigo. What the army would have done while undivided and still organized, was proved at the battle a few days later, before Corunna; nor after the action, should that fortress have been abandoned; for Soult's army could not face them in the field,—and was unprovided with a battering train.

For offensive operations against hostile insular colonies, the foregoing remarks are already sufficient, but as in general they imply not only landing but a siege, it is of the utmost importance that the most efficient means be employed for certain and rapid success, not only in the numbers and quality of the materiel, but in a body of Engineers and Artillery aided by Sappers and Miners; for by their means fortifications are reduced in the most speedy and least sanguinary manner; the system of destruction produced by shells and rockets may in a great measure be dispensed with, or at least confined to military defences; and delay is ever the cause of failure.

The two last maxims are of themselves sufficiently obvious, although disregard to them has been often exemplified; but some further illustrations of the principal rules of strategics may be necessary. We find, for example, in the wars of America, Lord Amherst operating by the line of Lake Champlain upon Montreal and Wolfe by the St. Lawrence upon Quebec; both successful, and yet two years without connection. The delay may be regarded as a consequence of the enemy's defensive lines (also two in number) being internal, while the British were external; and success arose from the strategical operations being rather distinct zones than lines; and that the direction of Wolfe's upon the St. Lawrence, which brought on the battle of Quebec, severed the enemy from all connection with the other line and the interior; at the same time that by occupying the river both were entirely cut off from their fixed base in Europe.

In the American revolutionary war, we find isolated expeditions scattered over a vast continent, on no point constituting a superior army, and every where inferior to the local militias; traversing vast woody regions, and terminating their career in defeat and capture. More recently we see them dispersed along the coast, occupied in landings for trivial purposes, and when re-embarked, leaving the enemy the claims of successful resistance.

In British warfare, the Roman maxim, *never to act offensively on more than one point at a time* (always excluding India), is proved to be judicious by the history of events since the war of the Spanish succession, when that question ought to have been decided in the Netherlands. The evil consequence of pursuing a multitude of offensive combinations at the same time was never better exemplified than in the failures of the simultaneous expeditions to Buenos Ayres, Constantinople, Alexandria, and Rugen, in 1807. Small debarcations for inadequate objects on hostile coasts produce no advantage equal to the risk, expense, and hostility they foster; for the local garrison and militia of the country are soon superior in force, and a hurried return on board causes union and exultation in the enemy. The landings at St. Cast and at St. Malo; that of Sir James Pulteney at Corunna; at Alexandria and Rosetta; most of those on the shores of the United States, were fraught with danger, odium, and inadequate results. Those on the east coast of Spain during the Peninsular War form a clear exception; they had a political object of importance to hold up; an ally to join and sustain; and, above all, they served as a diversion which compelled a whole hostile army to remain in that quarter.

Manœuvring lines, and those which nature has marked out, form separate classes.

Lines of Operation.

1. *Simple lines of operations* are those, when an army operates in a single direction from a frontier without forming detached corps. 2. *Double and multiplied lines,* when it acts on the same frontier with two or three isolated corps. 3. *Interior lines of operations* are so denominated when two or more corps are interiorly connected while they face an enemy posted exteriorly, whose connection is only by his flank or circuitous. 4. *Exterior lines* are such as armies form when they operate upon the two extremities of the enemy's front of operations, or on the two sides of two interior lines. 5. *Lines upon an extended front* are those which, though they be upon the same line, are separated into isolated divisions. 6. *Deep or lengthened lines,* such as commencing at the frontier basis, extend over a great space before they attain their object. 7. *Concentric lines* are those of several corps, or portions of corps, converging to one point. 8. *Excentric lines* are those of several corps, or portions of corps, *diverging* towards two or more points. 9. *Secondary lines* are those in the great combinations of armies which designate their relative connection while operating on the same frontier. 10. *Accidental lines of operations* sometimes are taken when the original plan of a campaign is altered by an unexpected event, such as being frustrated in an offensive operation and selecting a line of retreat towards a basis not in the original zone of operations, nor towards the starting point of the first basis.

To illustrate some of these definitions, let us suppose two armies like the British and Prussian posted in Belgium with either offensive or defensive intentions, and their magazines in the rear (perhaps at Antwerp and Maestricht), these places would constitute the territorial lines they have to cover, and the manœuvring lines would be in their front and to their flanks: if an hostile force could place itself in their rear, about Brussels, they would be cut off from them. Now, if the allies separated, and the Prussians took post on the Meuse, towards Namur, then the enemy would be cut off from his own; but as in that case the British could not singly remain in its position, and therefore would fall back behind the Scheld or towards Dutch Flanders, to re-open the communication with Antwerp, then the allied armies would present two exterior manœuvring lines, and the enemy a single central line, re-opening his own communication directly with the French fortresses by a new or accidental line of operations, and attaining his object by mere strategical means. But if the allied armies preferred to attack him with united forces, as both parties would engage with the chance of being cut off, the victorious would necessarily ruin his opponent. The movements and battles of Waterloo and Wavre would nearly represent this supposition, if the enemy's forces had moved from their base by the right bank of the Meuse, Namur had been unoccupied, and the allies had suffered them to proceed without counter manœuvres. So again, when Melas was defeated at Marengo, he was cut off from his temporary base on the Po; and with less jealousy and more enterprise, had he fallen back towards Genoa, and, instead of surrendering all the fortresses, given that city in charge to the English, he would, reinforced by the ten thousand men drawn from thence, and by the supply of *materiel,* which both the British naval stores and Piedmontese arsenals contained, have resumed the offensive: and if again defeated, the fleet would have carried his forces round without a surrender or the fall of any strong place, and the enemy would have been isolated in the plains without a single fortress. This instance is one of a most numerous class where theory makes a strong case, but circumstances were such that if they had been managed with skill, the results might have been very different.

In the first case is already shewn the superiority of a single line, and it as well

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as interior lines have manifest advantages over every other, since they facilitate most the great principle of carrying a superior mass upon the decisive point; for an army marching from its base by a single line of operations, the commanding general has only two momentous chances to provide against: 1st, that of being attacked unawares; and 2nd, of being turned and severed from his base. If he take the *initiative*, manœuvring with the intention of attacking, he will keep the adversary in check, and prevent a counter offensive; and if, in these movements, he can gain the hostile line of territorial operations, or throw his masses centrally, so as to prevent the enemy's corps uniting, he may totally ruin him. This was the aim of Napoleon in 1815: his concentrated masses were alternately to crush an opposing army, while an inferior corps kept the other in check; selecting the offensive line from behind fortresses at his pleasure, he could fall upon the allies before they were concentrated. The plan of his operations was good, had it been acted on a day earlier; and a day later he would not have been allowed to become the assailant. His momentary successes were due to the operations of a single against double lines; but when his intentions were sufficiently developed, and until then the necessarily extended positions drawn together, the continuance of the same idea became mere rashness; for the two allied armies were united.

An army moving upon exterior, double, or multiplied lines, is weakened in proportion as it is subdivided: the casualties in its combinations are greatly increased by the chances of accidents, misunderstandings, non-arrival of orders, and delays; errors are not so readily discovered or rectified, and a single misfortune in any one part paralyzes the whole. To the vicious system here noticed, must be ascribed the greater part of the failures of the Austrians, and more particularly of Alvinzi in Italy; and the seven years' war is rich in examples of success and reverses, mainly to be ascribed to the use made of single and of double lines of operations. In the wars of the French revolution, little was done by either party, scientifically considered, that deserves commendation: external and excentric lines, permanent positions, great detachments, were adopted by all; with manœuvring armies on the side of the allies; a belt of fortresses, numerical superiority, and, above all, a geographical frontier, which made all the movements of the French army comparatively single against double; internal against external; a concentrated against a dislocated base; and, adding activity against tardiness, it finally triumphed through one great military principle adopted by Carnot for the first time, namely, to send a vast reinforcement in a body to the army of the left (Dunkirk), and having by this mass ruined the opponent (the Duke of York), to move it to the next, opposite Charleroy, where, being thus again vastly superior, it broke the grand Austrian army: then again, proceeding to a third (Sambre and Meuse), and finally to a fourth army on the Rhine, each in turn becoming thereby superior, success was obtained for the whole campaign.

Napoleon manœuvred always on single lines, and in directions to cut off his opponents from all their resources: his strategics and battles were ever on the same principle; and, adding to these extraordinary activity and daring, he prostrated all the continental powers. But his deepened or lengthened lines of operations became boundless; and his daring, rashness; still, the value of the true principles of war made him successful against the false maxims of the enemy. In the Russian campaign, his single and internal lines broke through the multiplied and extended lines of the Russians, till their depth, and the change of the Muscovite system after the battle of Borodino, aided by the climate, exterminated his forces; and new armies could not again restore the superiority. Meantime the Duke of Wellington began in the Peninsula by creating a military base; then, although he manœuvred with inferior forces, by carrying the mass alternately on the north and on the south of the

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Tagus, he gradually widened and strengthened his frontier. Next, after having finally checked Massena in the position of Torres Vedras, he commenced operations on a single prolonged line, always in the direction of the enemy's communications with France, and, therefore, so dangerous to them, that in order to compel his army to retreat towards the Portuguese frontier, they were obliged to collect far superior forces, and to abandon the whole south of Spain. Soon after, Madrid itself, and then the north, were similarly lost by the operations and movement of battles ever turning the communications of the French, and the Pyrenees themselves gave no lasting security; the territory of France being first invaded on that side, and a British army operating in Gascony, before the Rhine or the Rhone were crossed by the allies. No stronger example of the superior advantage of a right use of lines of operations in the direction of an enemy's flank and rear can be produced, than the result of these operations in the north, still further made manifest when they are compared with that on the south of the Tagus, where the victory of Talavera was useless, and followed by retreat. It was a great warning given to Statesmen, not to violate the first principles in war upon bare political calculations, or on the questionable sincerity of remonstrances from inefficient allies.

From the results of the scientific campaigns of the last wars, the value of the principles above indicated may be summed up under the following heads:

1. A double line of operations is advantageous if the enemy likewise acts upon two lines, provided these be exterior and at a greater distance to operate simultaneously than your own upon the same field of action.

2. An army having interior lines, being more concentrated than those of the enemy, can by strategical movements destroy first one, then the other parts of his forces, by alternately carrying its masses upon each point,—as was exemplified by the King of Prussia in 1758, and subsequently in the revolutionary wars at Mayence, Würtzburg, Emendingen, at Lonato, Castiglione and Bassano, Stockach and Zurich, Abendsberg and Eckmuhl, as well as in the Peninsula, before noticed.

3. To effect this purpose a corps is left to occupy the attention of the army for a short period, by various movements, or by an intrenched position; in all cases to act really on the defensive, retarding the enemy's advance at defiles, bridges, &c., until, by slow retreat, time has been given for the main army to strike the intended blow, and then the order of operations is reversed, by the retreating corps being reinforced, till it is in a condition to resume the offensive with superior forces.

4. Thus, with equal forces, an external double line will always be worsted by an internal, because these last, being in closer connection, can most readily reinforce each other, provided their commander manœuvres with intelligence and rapidity. Even the ignorant energy of Tippoo Sahib proved in several wars the advantage of central operations against external lines, such as Lord Cornwallis and Abercrombie, with their allies, used against him.

5. A double line of operations becomes still more dangerous when its parts are separated by several days' march.

6. Simple and interior lines, on the contrary, are always most safe; because they admit the mass of forces to act against the divisions of the enemy, if he be so imprudent as to leave one or more in that condition.

7. A double line of operations, however, may be adopted with success, if the forces employed so greatly exceed the enemy's as to outnumber them on both its parts.

8. Two interior lines, mutually sustaining each other, and facing two exterior

lines at a certain distance, must avoid being compressed into a small area, for the two hostile bodies might then co-operate simultaneously.

9. But they should not manœuvre at too great intervals, for the enemy, by a sudden advance on one, might have time to crush it while it is weakened by detachments to the other, and thus gain a decisive advantage.

10. It being the advantage of a Commander to divide and isolate an opponent's army, his manœuvres should never have the object of drawing his whole forces unitedly upon him, notwithstanding Tempelhoff's boast that Frederick the Great effected this in 1760.

11. When armies operating exteriorly amount to above 100,000 men on each line, as occurred in Saxony (1813), and in Champagne (1814), they possess a consistency that is not so easily affected by interior lines: they can recede and advance till the intervening area is so diminished, that the forces within it risk to be simultaneously attacked, or they must escape in a direction least expected, that is, where the retreat is most baneful to themselves. Proofs of this law are found in the operations about Leipzig, and in the last strategical movement of Napoleon in 1814, by which he lost his communication with Paris and his crown.

12. But notwithstanding these events, concentrated lines maintained him in 1813 about Dresden, and the next year in Champagne, until yielding more to temperament than necessity he manœuvred excentrically with inferior forces at all points, and at the same moment in Bohemia, Silesia, and the sands of Berlin, and suffered reverses in all: so again the next year in France; while the allied forces were in extreme difficulty for subsistence, his impatience to act on the offensive broke through all the principles of war, and Paris was lost without an admissible reason. The history of individual and national temperament in war is indeed a subject replete with fearful lessons, if it were properly handled.

In order to complete the view of territorial and manœuvring lines, it is requisite to consider them as they are affected by the configuration of frontiers, for the base of operations depends thereon, as is manifest from proofs already given.

1. Only one army should operate on the same frontier, though reserves, &c., may be kept in second line. That army is based usually on the last line of fortresses, the most defensible river, or mountain chain, whence offensive movements can proceed, and to which defensive refuge must be had with the greatest trust for safety.

2. An army may have successive bases. A French basis, defensively viewed from the side of Germany, would be primarily on the Rhine, second on the Moselle, third on the Seine, and fourth on the Loire.

3. A first basis becoming by the reverses of an army exposed to the enemy, its character is changed to a line of defence, particularly if there be fortresses upon it: thus the upper Rhine, a broad and rapid stream with fortifications on many points, forms an excellent base and defensive line; for none are good that have not more than one fortress upon them.

4. An army may operate offensively with advantage upon the centre of an hostile frontier, even when defended by a line of fortresses, as the Austrians under the Prince of Coburg did in Belgium in 1793-4, and the French under Pichegru retorted in 1794. The first failed from the detachment system, albeit the attack upon Dunkirk was advisable, to secure the right flank and keep open a more direct communication with British resources: but the grand army should have masked Lisle. The second was successful, not by the direction of his line

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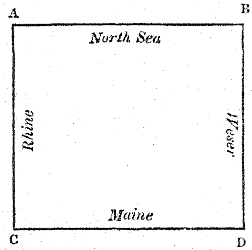
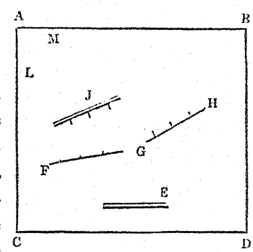
of operations, but by the superiority successively given to each army by the able measure of Carnot, as already mentioned.

5. The best basis is that which forms a re-entering angle or two sides of a square; such as the French made of the upper Rhine and northern Switzerland towards Germany, or southern Switzerland and Piedmont on the Italian side; for they offer a double front of attack, outflanking an advanced hostile army, and a double facility of retreat.

6. Jomini points out the configuration of a theatre of war being in some measure quadrilateral; as for example, the French army in the north of Germany, from 1757 to 1762, and the operations of Napoleon in 1806.



The side A B being enclosed by the North Sea, the side B D by the river Weser, base of the army of Prince Ferdinand: C D representing the river Maine: base of the French and A C the Rhine, likewise in possession of the French: their armies operating offensively on the sides A C and C D, had the third A B or North Sea in their favour, and therefore B D was the only side they were to gain by their manœuvres to have possession of the four sides, and consequently to have the base of all the communications of their adversary. A diagram proving this still more clearly is found in the next figure.



The French army E proceeding from the base C D to gain the position F G H cuts off the allied army J from the side B D, its only communication and base. It would thus be driven into the angle L A M, which is formed near Embden, by the lines of the Rhine, the Ems, and the Sea; while the army E could always communicate with C D or the Maine. But though a re-entering angle of frontier, or of operations, as regards Switzerland and the north of Germany, are true upon systems of undisguised aggression and servile submission of the half of Germany to the gigantic schemes of France, the re-union of interests and national spirit of the Teutonic race will in future render similar undertakings much more impracticable. Two sides of a quadrangle present besides the inconvenience of double external lines, and may be treated accordingly.

Further discussions on the configuration of the territorial surface of a campaign occur in Jomini, where he reviews the operations of Napoleon against the Prussians and Russians; but as they are included in the foregoing demonstrations, and belong entirely to the gigantic system of that period, reference is recommended to the author, and it will be sufficient here to notice his two concluding maxims:

1. To move the masses upon the decisive point of the line of operations, that is, upon the centre of the enemy if his forces happen to be scattered, as the Russians were on opening the campaign of 1812, or upon an extremity if he is on a contiguous line.

2. To make the great effort in the case of a connected hostile position upon that extremity which affords no means of retreat, or which leads upon his communication without endangering one's own.

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Although these have incidentally been noticed in the foregoing pages, they still demand some further remarks. Passive defence,—that is, where the troops are shut

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up in fortresses, or an army is intrenched without taking the offensive on the least prospect of advantage,—gives no security to States, as was felt by the Dutch republic on more than one occasion. But as defensive measures imply inferiority of physical force, natural and artificial obstacles are made to contribute to restore the balance. That defensive system is the best which embraces the greatest number of offensive facilities, such as already adduced in the remarks on single and internal lines of operations; because they best anticipate and counteract the progress of invasion. Eminently serviceable are rivers with fortresses and têtes de pont on the opposite side, such as Prague on the Moldau, Maestricht on the Meuse, and particularly Coblentz with its whole system of defences, and Ehrenbreitstein on the German side of the Rhine. Namur on the Meuse is equally well calculated for this purpose; and if the vitality of Belgium were sought to be maintained, a fortified position between Lier and Antwerp, with the Ruppel and Scheld in the rear, would bid defiance to any hostile force from the south, because while all the great military and commercial interests are covered, the communication with the sea may be kept open by inundations, provided artificial strength were given to the front and flanks by timely well-constructed works. In all these cases the defensive army may place the river or the works between it and the enemy, as often as may be necessary; while the offensive force is obliged to cross and recross, or to extend his position in such a manner as to expose some part to be attacked and cut to pieces before it can be assisted. On the Danube the Austrians had an excellent defensive line; but not being any where secured by fortifications, to give the required facility to their movements on each side of the river, it failed to answer the purpose. Since the peace, excellent measures have been taken to obviate this want at Linz, Passau, and Ingolstadt; others are now in progress at Ulm; and the formidable position of Salzburg covers the Hereditary States from hostile approach through the Noric Alps. The insignificant fort Bard, in 1800, arrested for several days the principal column of Napoleon's army from coming down the St. Bernard into the valley of Aoste; and with slight additional attention might have deranged all the conqueror's projects, as before noticed. Again, the importance of certain defensive points is manifested in neglecting to secure the noble roads which Napoleon had constructed across the Alps; for the Austrians made two successful invasions into France by these, shortly after they were finished.

Fortresses likewise protect magazines, hospitals, and stores of an army, and save the matériel after a defeat. Prague in 1757 secured the Austrians; and Pampeluna, for a time, all that escaped from the rout of Vittoria. But in order to obtain from them the degree of security which can reasonably be expected, they should not be too numerous, because they demand such a proportion of troops for garrisons as to absorb whole armies; and the expense of construction is enormous: nor should they be small, for then they are easily crushed by the abundance of artillery now in use; nor all on the frontiers, because an enemy penetrating beyond them, the great arsenals, dépôts, founderies, &c., of the State are no longer in reach of the defensive army. The large cities or towns which happen to occupy intermediate sites on the great lines of defensive operations, between the capital and the frontier (and if possible on a navigable river), should be selected, fortified with all the rules of art, and in some cases covered by an intrenched camp, and they should communicate with the seat of Government by established telegraphs. Camps defended simply by intrenchments of field-works, not solid fortifications, are more commonly the work of the eventualities of a campaign, and, on great fronts of defence, are seldom tenable. The Bavarian position on the Schellenberg in 1704 being unfinished, and with insufficient means of retreat, should have been abandoned. That of the Russians at Drissa upon the line of Moscow was abandoned. The French at St. Jean

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de Luz and Toulouse were carried by storm: that on the Isla of Cadiz was maintained in one war and lost in the next. The lines of Lisbon were maintained, and saved the kingdom. That of Dumourier, near the wood of Argonne, arrested the progress of the Duke of Brunswick in 1792; and that of Kutusoff at Malojaroslaf, near Tula, forced the French to retire by the route they came. Both these last were in the flank and rear of the offensive armies, and offer proofs (when circumstances do not permit that they be turned) how decisive they are of events when firmly maintained: one had fortresses at his back, the other a Russian winter in his favour. Bonaparte, in 1814, after the action of Brienne, vainly believed the allies would follow him towards the Rhine, when they were already at the gates of Paris, and by this enormous mistake lost the empire. To sum up defensive war in one maxim, it should be stated that "it does not consist in covering every part of a State, but in preventing an enemy from obtaining that object which will accomplish the end he has in view."

TACTICS. Battles.

The plan of a campaign and the strategical movements are both entirely directed towards victory, or so many preparatory dispositions to arrive at the successful crisis of a battle; therefore the rules applicable to them constitute the most important branch of the science of war, and unless they are well understood, all other knowledge is comparatively useless. But even here the direction of the line of operation, and then of tactical measures, is so influential, that an army may be manœuvred out of its defensive plan, and forced either to retreat or to fight on disadvantageous terms.

Though fixed rules are exceedingly difficult to be applied, still among the first is that of operating with a superior mass on the decisive point, because the physical force of organized numbers in arms furnishes the unerring element of victory, when the moral qualities of both armies are equal. The means of bringing this force to bear in the most advantageous manner is the art of fighting; consequently courage and fortune being nearly balanced, that General who can operate with the largest mass upon the most decisive point must be successful. But for this purpose the combination must be such as to produce a unity of movements, conducting simultaneously to the same object; and the masses so produced must act with energy against the enemy, for mere superiority on the given point without action would be useless; as was signally exemplified at Fontenoy, where less than half of an inferior army broke through the hostile position and then halted nearly four hours, waiting the re-organization of the enemy's line in order to be—defeated.

The following maxims are of general application:—

1. No favourable opportunity should be postponed to the morrow.

2. No battle should be given but for an important object, unless the circumstances render one unavoidable.

3. No battle undecided at nightfall should be considered ended until at least one more great concentrated effort shall have been made to convert it into a complete victory before total darkness produces the cessation of action. Napoleon, on more than one occasion, obtained his victories by such an unexpected effort, and particularly at Ligny owed his momentary success to this measure.

4. After a victory the enemy should not be allowed to recover: fatigue must be disregarded, and the pursuit made incessant; for the enemy is surely as much exhausted as the conqueror: if he can flee, the other must be able to pursue: the troops should be concentrated as much as possible towards the close of a successful action, not only to complete the work satisfactorily, but to

repel those last and desperate efforts which have more than once turned the fortune of the day.

As in lines of operations, so on fields of battle, it is necessary to avoid, 1st, forming isolated divisions; 2nd, ordering extended movements which deprive the army of a part of its strength and enable the enemy either to ruin the main body or the detachment; 3rd, positions with too great an extent of front; 4th, suffering obstacles, rivers, ravines, &c., to separate the wings, or impassable rocks to intervene between the columns, exposing them to be separately defeated.

The finest combinations are,—oblique orders of battle; those with a wing reinforced; those which outflank the enemy; and those which produce a perpendicular line upon an extremity or a scattered centre of the enemy. These are, theoretically speaking, always successful, because they present a whole line to an extremity, and therefore bring into action a greater force than the enemy, in conformity with the fundamental law in all military combinations of "*effecting with the greatest mass of forces* a combined attack upon the decisive point." Even where the victory is ultimately lost, the manœuvre shews at what risk and price it must be met, as in the case of Albuera, where Soult's front came upon the right flank of the Spaniards with such rapid progress, that the British in the centre, in order to form a new front, were obliged to extend the line at an angle to the rear, which was not effected but with great risk and loss.

To effect the purpose of the foregoing maxim there are many methods, though in general it results best from taking the lead in the movements, because

1. An army in that case can conceal the intended manœuvre until it is in full operation, either when commencing at the distance of one or more days' march from the enemy, or by the nature of the country when in his vicinity.

2. The Commander should not take into his calculations that the enemy will be informed of his movement, penetrate his design, and oppose it by the best possible means from the instant that it is begun. An ancient and signal example of turning a flank in sight of the enemy occurred at Flodden, where Surrey, with inferior forces, attacked the King of Scotland and cut off his retreat. At Prague, Prince Charles of Lorrain and Marshal Brown both saw the Prussian left, led by Marshal Schwerin, prolong their movement to outflank the Austrians; and yet, although the Imperial army stood in the open plain upon the chord, and their opponent upon the arc, had moreover a swamp to cross, in some places in single files, yet Warnery with his hussars arrived beyond the extremity of their right, and by this means turned the fate of the day.*

3. When two armies combine from the distance of several days' march to place the enemy between two fires, their dispositions must emanate from a double line of operations against one that is single, and therefore they must expose themselves to be defeated separately, if the enemy takes proper advantage of his central position. Such a manœuvre is similar to a movement made at a distance against the flanks, and belongs to those which cannot produce a simultaneous effect at the moment required. Such was the corps under Sir Ralph Abercrombie in the Helder expedition detached to Hoorn, and obliged to hasten back without seeing an enemy. Such was Grouchy's at Wavre, during the battle of Waterloo.

4. Another maxim of battle is to direct the movement against a weak point

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* Marshal Brown, forgetting his flank, charged the disordered Prussians with his grenadiers, and thus gave time to their cavalry to prolong the movement. Haddick's hussars trotted to the right, but were finally outflanked by half a squadron.

of the enemy, when that point offers the greatest advantages. An attack to the front is always unadvisable, when a concentrated effort can possibly be made upon the extremity of an enemy's line. Against double and scattered lines of operations it is preferable to direct attacks upon the central points; for the mass of forces having ruined a central division, the corps to the right and left of it can no longer operate in unison, and are forced to retreat excentrically, as was proved in the disasters of Wurmser, Mack, and the Duke of Brunswick, and at the close of the battle of Marengo, where Kellermann's cavalry broke through an opening in the Austrian line, and though superior in that arm upon the field, they had none present on the spot to remedy the consequence.

5. A deep column being attacked on the head is in a similar condition as an extremity of a line; both the one and the other are engaged in succession and defeated, or what is termed rolled back. Such were the events of Rosbach and Auerstadt. Bearing out the same principle which guides lines of operations, the manœuvres of attack on a battle field are equally decided by the same causes; namely, by decisive operations on the flank and rear of an enemy. Such was the manœuvre of the Duke of Wellington at Vittoria, and the success complete. Soult at Albuera and Junot at Vimiera aimed at the flank, and both these events shew that counter-movements with resolute well-trained troops may defeat the attack, because the defensive army being on the chord or shortest line, can readily prolong its front to equal or pass beyond the assailant. The battles of Ligny and Waterloo belong to the principle of a double interior to two external lines modified into a single mass breaking in upon the centre of a scattered line; Napoleon aiming at the two allied masses separately, by moving two-thirds of his force alternately against the principal army and keeping the other in check with the remaining third, until his first blow should be struck. He succeeded in the first part of his plan, but failed in the second, and from the headlong system of his battles his defeat was irretrievable and fatal. These battles, and those of the grand allied army when it debouched in 1813 from Bohemia upon Dresden, and when Napoleon retorted by sending the corps of Vandamme across the mountain ridge to Culm, also the detached force under Grouchy at Wavre, and the British late on the same day at Halle, attest that wherever detached corps are out of hearing of the cannon they become useless to the main operation, often are made to suffer so as to counterbalance a victory, or, when successful, are found to have produced no advantage equal to the risk.

It is to obviate the too frequent necessity of sending great detachments to cover the flanks of armies at some distance, that these are usually posted in strong or in partially fortified towns, where the defences should always be placed in that condition of resistance by means of closing the gorges of bastions or loopholing and strengthening particular buildings; for thus a less force may retain them until relief can come and the masses of the army are less reduced.

Enough has been said on the advantage of attacking the extremity of a line and the conditions which allow the onset to be carried against the centre of a scattered line: to these may be added the only case when both extremities may be attacked; and that is, when the assailant is possessed of at least double the numerical force of his opponent: for then it is important to bring into action at the same moment the greatest possible amount of that superiority. Such was the occasion which caused Daun to attack the Prussians in this manner at Hochkirch; and again, when the allied armies fought at Leipsig.

Inferior corps have sometimes acted offensively in a divided form: this was the

case at Kollin by an improper execution of the intended system of battle; for Frederick II. had theoretically in view an oblique attack; but his generals and he himself were as yet so little competent to work it out, that the army formed no contiguous mass, and became parallel to Daun's front. At Crevelt an inferior corps turned the flank of an enemy who was superior in force, but ill commanded.

All fields of battle have a decisive point or key. It is not, however, always to be found in the strongest part of the position, but generally where the communication with the base of operations is most readily cut off; for if an army is forced on the other extremity, it may retire with little more loss than the assailant. When the lead is taken in operations, it becomes of the utmost importance to be exactly informed of the nature of the country in front, and still more of the enemy's movements and positions: spies are then of great use, but still less so than partisans thoroughly versed in the art of watching an enemy with small detachments: these should consist of parties of light cavalry added to infantry where the ground will permit. The celebrated Lloyd was remarkable for the talent of conducting these apparently small operations, which, nevertheless, though too much neglected, are often the cause of safety and of victory, and therefore require a careful training, with a selection of the most intelligent officers to command them. It is the best practical school of war.

Battles are either offensive or defensive; therefore, what is recommended to be done for gaining the first is most to be guarded against in the second. They are reducible to three systems: 1, includes defensive battles where the enemy is expected in a strong position with no other intention than maintaining it. Such were the French under Tallard at Blenheim, of Villeroy at Ramillies, of Marsin at Turin, of Villars at Malplaquet, of Saxe at Fontenoy, Daun at Torgau, and the results shew their general disadvantage. 2, is the opposite system, wholly offensive. It consists of movements of attack wherever the army may be found. Such were those of Marlborough at Blenheim, Ramillies, and Oudenarde; Frederick at Leuthen, Zorndorff, and Torgau; Napoleon at Jena and Ratisbonne; Wellington at Vittoria; and the allies at Leipsig. 3, is the middle term between the above. It consists in selecting a position carefully reconnoitred beforehand in its strategical applicabilities and advantages of ground; there to await the enemy, and to fix upon the proper moment of passing from the defensive into offensive measures with the best chances of success. To these belong the battles of Rivoli and Austerlitz, of Blucher at Katzbach and Laon, and of Wellington at Salamanca and Waterloo. The selection of the class of action is not always optional; the circumstances of the moment, the character and number of the troops in hand, the season and nature of the country and ground, all enter into the consideration, and leave only the following generalities for data.

Orders of battle, or the most appropriate disposition for leading troops into action, should possess the inherent qualities of mobility and solidity. To attain these two objects, troops which are to remain on the defensive should be partly deployed and partly in column, as the allied army was at Waterloo, and the Russian at Eylau. But the corps destined to attack a decisive point should be disposed into two lines of battalions formed into columns. Such were the British at Roleiza, and the centre and left of Napoleon's grand army at Dresden. Each column may be in grand divisions of battalions, and if it is considerable in depth, may be best formed on two central grand divisions, which, moving forward contiguously, readily constitute a line by each marching up obliquely to right and left. A beautiful example of this formation was produced by Marshal Lehwald at the battle of Jagerndorff.

1. The best mode is to act offensively on all occasions when the troops are inured to war and the ground offers no extraordinary features, especially

2. When the strategical circumstances of the parties are such that one is obliged to attack the other without considering the localities; as for instance, to prevent the junction of two hostile armies, or to crush an isolated corps, &c.

3. But the defensive is advisable where the topography of a field of battle is difficult of access, from natural or from artificial causes, and the army is composed of different nations trained in different manners and imbued with different feelings: it is preferable to receive the attack in a well-selected position, with the determination of assuming the offensive, when the enemy shall be exhausted by the first efforts.

4. Also when particular reasons, such as an extreme inferiority of numbers, forbid any other than strictly defensive measures; such as Eugene took at Chiari, Abercrombie on the Zyp, and Moore at Corunna.

There are strategical battles so much affecting the flank and rear or the communications of the defensive party, that sometimes they are decisive of a campaign: such was that of Marengo; and again, as a battle, more complete at Vittoria.

Orders of Battle.

Battles, again, whether offensive or defensive, notwithstanding all the varieties of ground and changes of position, are reducible to three orders; each subject to some modifications.

1. The simple parallel order, or that where the hostile forces face each other in parallel lines, to advance or receive the attack. In these, accident or some condition of superiority in courage, artillery, or discipline, decides the contest, and not the capacity of the commanding General.

2. Where no other combinations are practicable, there is the second order, or that with parallel lines reinforced upon one extremity. To this class, especially if dispositions with an angle to the front or rear are included, most of the great victories of ancient and modern times may be ascribed; for although it is not the most perfect in theory, it is the most constantly applicable in practice, under almost every possible character of ground or counter-disposition of the enemy.

3. The oblique order of battle is the third and the best class of tactical dispositions; but in the application great simplicity of combination is necessary, and great prudence in the execution. Against a manœuvring army well commanded it will always be difficult to apply it; but when produced the effect is instantaneous and decisive: it is the triumph of discipline and of grand manœuvre.

Positions.

On the extensive subject of position, the following maxims offer some particulars. 1. The best military positions cannot cover a State merely by being occupied and maintained. 2. Every position has two keys or decisive points; one the strategical, whereon the army hinges in relation to its communications with the base of operations; and the other, depending on the nature of the ground, is the topographical, which being attained by an enemy, dispossesses the defendant. In this case, the defeated army, as at Neerwinden, in 1693, and at Neerlanden, in 1793, is merely driven back upon its line; but in the first-mentioned it is cut off from it as the French were at Vittoria, and therefore the result, if properly followed up by the conqueror, is always disastrous to the routed. 3. An army in position to risk a battle on the spot should have the front and flanks most carefully reconnoitred and

watched, its internal communication opened and connected, and, if there be be time, the roads in rear, to the distance of a march at least, examined and sketched. 4. Strong corps are not required to watch the avenues; the service is performed better by numerous small posts. The practical importance of the two last rules is exemplified by the surprisal of the Prussians at Hochkirchen, of Korsakow at Zurich, and Murat at Tarutina. 5. On ground of difficult access, such as gardens, enclosures, marshes, rivulets, vineyards, steep heights, &c., the defensive line should be deployed and covered with skirmishers; but the corps destined for attack are best in columns formed on their centres. At the proper moment these should be flung upon the enemy in the same order. If it be desired to display a greater front of line, a part may be deployed, behind which close columns should be concealed. 6. A superior army should never wait to be attacked, still less wholly deploy into line: if compelled to remain in its post, no more troops should be formed in line than are requisite to repel the enemy, while the remainder, formed in columns, should be so placed as to strike a decisive blow, as Lord Hill's corps did at Waterloo. 7. Villages, farms, or cassinos covering the front of armies, should be occupied by light troops and detachments lining the enclosures and walls, the roads passing through them armed with cannon, the first line being sufficiently near to sustain and be sustained by them, and the outlets to the rear open. The events at Blenheim, Ramillies, and the château of Goumont at Waterloo, all attest results according as this principle was well or ill applied. 8. An army appuyed perpendicularly upon a river should not be attacked on that side, because the enemy changing front en masse towards the stream, it might be hemmed in between the foe and the water. Now if the principal attack is made on the other wing, that chance is in favour of the assailants, because the extremity being turned, the whole line will be forced back upon the river. This would have occurred to Hiller's corps at Wagram, if a timely retreat had not saved it; and a similar fate awaited the French at Talavera de la Reina, had they persisted in an attack upon the Spaniards. 9. A repulsed attack should not be pursued unless the result has been decisive, because it might be the intention of the enemy to draw the forces out of their advantageous post,—a stratagem of great antiquity. 10. Positions may be occupied in an apparent disjointed form, provided they have the required facility for timely re-union. Several are indicated in the secret instructions of Frederick II., and that at the siege of Olmutz, where he had a corps at Littau, while he remained with the covering army at Prosnitz, and in order to connect the two masses at will, a smaller on the hill of Hrad, between Namiest and Laskow, to serve as an intermediate point, is very remarkable. Orders were given to the corps at Littau, in case of attack, to retreat towards the King's, and if a superior force attacked the covering army, he was to retire towards the other; but if timely warning was received, all were to unite in the position of Gross-Jesnitz. 11. No position should be attacked on its strongest point, as the Austrians did at Breslau; but if the hostile position be prolonged by a detached corps, the principal effort should be directed against it; because, if that be defeated, the main body is turned and the affair decided. 12. Armies may be posted behind a ridge of hills, with defensive points upon the summits. These should not be attacked without an exact knowledge of the position they cover, and precautions taken accordingly. The events of Austerlitz and on the Katzbach prove the necessity of precaution, and at Lowositz the neglect of occupying the hills was the cause of Marshal Brown's defeat, and of the Saxons being captured at Pirna. 13. Neither position nor plan of attack admits the line to be intersected by any impediment, such as a river, morass, or deep ravine, because the enemy may act defensively on one side and offensively on the other, as happened at Dresden, where the left of the allies, separated from the line

by the ravine of Plauen, was severely handled. 14. An army immoveably fixed in a position may be turned on both flanks. Attempts on either, however, should be met by prolonging a flank, as the British effected to the rear at Albuera. 15. There are positions which cannot be turned or attacked obliquely. If the enemy cannot be induced to quit such by stratagem, the best mode of attack is by the centre, strongly reinforced; but still such positions often may be masked by small corps, because the nature of the ground, which renders them unassailable, is likewise an impediment for debouching from them.

Attack.

Angles or formations en potence and oblique attacks have been repeatedly noticed in the foregoing pages. As both are thoroughly understood by military readers, we may refer those who wish to search further into these questions to 'War,' Encyclop. Brit. 6th edition, and Jomini, 'Précis de l'Art de la Guerre.'

Marches, however, in columns to the front flank or rear, which must terminate in deployments or échellon formations, are fit only for the elementary tactics of reviews; they can never be safely applied on a great scale before an enemy. The present system of moving by corps obviates much of the older organization by lines, and renders the march manœuvres of Frederick less applicable; nevertheless, they are still the best for corps that are obliged to manœuvre in the presence of the enemy, and especially for the class and number of troops usually available in British expeditions, whether it be to engage in front or to turn his flank. An examination of the mechanism of the Prussian columns at Kollin, Leuthen, &c., proves that the army forming two lines, each broke into open column and moved in prolongation of the direction they both received, either with the right or left in front: by this method the army could, 1st, execute all necessary movements united, without danger of being assailed in detail, because the columns of lines were not further asunder than is requisite for battle. 2nd, The enemy could neither cut them off nor penetrate between them. 3rd, In taking the direction of the intended line, the army when reaching the ground is formed in a few minutes, that is, in the space of time required for the word of command to pass down the columns *to wheel into line.* In this method the only precaution required was to keep an advanced guard at first on the head of the columns, then as they passed obliquely towards the hostile flank to have it posted between them and the enemy, protecting the march, and by occupying intermediate heights dislodge the enemy's posts of observation, and in this manner conceal the intention of the manœuvre; the enemy thereby being kept in suspense, and consequently immoveable. 4. As the army takes only two or three hundred paces between the columns and the divisions, no more than their respective distances to form into two lines, the manœuvre is easily executed with precision. 5. The flank of the enemy being attained by concealing the movement, as before noticed, the rapidity of forming by merely wheeling into line will anticipate the hostile extremity forming an angle or change of front; consequently he will be overpowered and rolled back as fast as the new division to the front advances. 6. If two columns of the length of the line of battle are not desired, or the ground requires a modification, four columns may be formed by doubling up the lines or by marching by wings without increasing the difficulty of forming; the only precaution requisite being that the second and fourth halt in proper time, leaving the first and third to proceed until they have disengaged their rear from the heads of the other two. While halted, they protect the march of the two in motion, and then follow in their track or wheel into line, as may be ordered.

The orders of open columns marching to a flank are in truth manœuvres, not route marches, and answer best against lines in position and columns of deployment, and even against columns of march, if the movement against them can be prolonged

unperceived, as was the case at the battle of Rosbach. But an open column taking ground on a field of battle, supposing the right to be in front, cannot change the direction of its head to the left, if according to the regulations all the sections must wheel into line on their true or left pivots; for then it would present the back to the enemy. Such a case occurred at Laswarree, where the British infantry, marching to the field, the column with the right in front, after crossing the Mahnusnye, a deep sunken rivulet, found itself proceeding against the enemy's right; but that wing drawing back into a new alignment, and forming an angle to the rear, a prolonged movement in this direction would have produced a parallel order of battle, and exposed the line to seventy pieces of cannon: advantage was therefore taken of a ravine which led to the right flank of the new position, and accordingly the column turned to the left; and by so doing, when it arrived at the point to form several battalions, in obedience to the rules and regulations, wheeled into line and stood with the back to the enemy, requiring to be countermarched under a storm of grape shot, and leaving, by this delay, all the brunt of the action upon the 76th regiment, and about two battalions of Sepoys. These remarks, it is true, belong to Logistics, but they are mentioned here to shew the propriety of some alteration in the regulations. The flank movement, though ably conducted, was nevertheless countermanœuvred by the formation en potence to the rear, and the decision of the day was due to charge with the bayonet. An army in column, however, finding itself suddenly in presence of one in line at right angles, has no other resource than to endeavour to deploy the leading brigade, while the next behind it changes the direction towards a flank; converting thus a probable defeat into an offensive movement and oblique attack, which will check and intimidate the enemy without incurring confusion.

Retreat.

Retreats are operations in war of all others demanding steadiness and cool self-possession. An army that is routed and turned can seldom maintain sufficient consistency to effect an orderly retreat; one that is merely dislodged from a position, not being dislocated, may retire without disaster, as the Austrians and Prussians have often effected; but the finest manœuvring operations belong to those who find it expedient to retrace their steps towards the base of operations without having lost a battle. Massena's retreat out of Portugal; the three, and in particular the last, of Lord Wellington's out of Spain, are remarkable. The concentric retreat of the Russians in 1812, and especially the left corps under Bagration, again deserve high commendation.

In the choice of a defensive position, considerations regarding a safe retreat should never be omitted. Waterloo, notwithstanding Napoleon's condemnation of it, was admirable for this purpose, because no pursuit en masse could take place beyond the depth of the field of battle, where the edge of the forest of Soignies gave immediate shelter to broken infantry, and the several broad roads through it the means of withdrawing the matériel. Mont St. Jean set on fire would prevent the pressure of columns by the great road; and if the allied armies had been there divided, by the French breaking through the interval between them, the British could easily fall back behind their right across the Haine to the heights of Anderlecht, while the Prussians falling back to Wavre could not be arrested by Grouchy. Retreats must be regulated by circumstances: if, for example, the army can screen itself behind a broad river, a chain of mountains or of fortresses, in one or two marches, it may be best to divide the forces into several corps, in order to attain that object with the least delay and impediment; but in general it is best to remain concentrated, contesting every point by means of a strong rear guard, the commanders of which should

be particularly careful to assign beforehand rallying points, in case any corps should be broken. Much may often be done, on these occasions, by the Engineers forming small defensive *Palànka** redoubts, always the work of a few hours; and for this purpose all the regimental pioneers in the army, with a few battalion officers, should be placed at their disposal: these and the Sappers will be sufficient for works, and will contribute in making abattis, destroying bridges, and rendering boats unserviceable to the enemy. A retiring army is not always obliged to fall back upon its own base: sometimes the direction may be changed to a new one, as Frederick II. did in 1758, when, raising the siege of Olmutz instead of returning into Silesia, he changed his line and marched into Bohemia. Napoleon was advised, before the battle of Leipsig, to change his to the Elbe, and manœuvre between Magdeburg, Hamburg, and Wesel.

Pursuit.

Pursuits should be conducted upon the same principles as strategical lines and battles, always aiming at the communications of the flying enemy; but in this case more than any, no relaxation should be allowed; no time for the re-organization of his broken corps, or for preparing means to retard the pursuer. If his communications can be turned, it may be expected that the whole matériel of his army will be captured. The pursuer should disregard having his most advanced troops checked or even repulsed; he may be sure the enemy cannot continue to hold his ground, and therefore should attack him again and again, till he obtains his object: if he can drive the fugitives to the shores of the sea, a great lake, or deep river, he may compel them to surrender; therefore no battle gained should be without a pursuit to the utmost, provided no unanswerable objection be opposed to it.

Sieges.

Sieges, in Lloyd's opinion, should never be undertaken but for the following objects. 1. "When a fortress is situated upon the passage which leads to the enemy, rendering it impossible to penetrate further without the capture of it. 2. When a fortress intercepts the communications, and the country is unable to furnish the necessary subsistence. 3. When a fortress is wanted to facilitate operations by covering magazines formed in the enemy's country. 4. When the enemy's principal dépôts are within one, which being captured would cripple his future ability to keep the field. 5. When the capture of a fortress produces the conquest of a considerable portion of country, and enables the besieger to winter in that vicinity." To these might be added,—6. The recapture of a fortress essential in the defence of a frontier.

Although the wars resulting from the French revolution were carried on with such a prodigious number of forces on both sides, that the ordinary rules of war were often safely disregarded, and sieges in particular were but little put in practice, yet during the whole of their course British armies and their allies have repeatedly failed in necessary sieges, and thereby endangered the success of a campaign, if not of the whole war, from the want of a sufficient establishment for the Engineer department: it was not until the last years of the struggle, when blood and treasure, so often wasted in vain, produced the conviction of ameliorating that most important arm in the service; and it is a naturally great satisfaction to the Army to see continued practical improvements in the operations of the Engineers,—the experiments with mines, pontoons, &c., sedulously encouraged by the head of the Government.

* Stockades with the posts left of unequal lengths, are supposed to render the escalade more difficult: the joinings of these palankas are sometimes covered by a second row, breast high, so as to render the whole musket-proof at all points.—Vide 'Stockade.'

Covering sieges is best performed,—1. By the army advancing to attack the force which attempts to relieve a town besieged: it is the best mode to produce a speedy surrender. 2. If the enemy approach with an imposing mass, the siege should be raised; all the forces united, in order conjointly to give battle. 3. If a victory is obtained, the siege may be resumed, while the pursuit continues and the enemy is not in condition to return before the capture of the place. 4. A siege undertaken in consequence of anterior success should have the covering army, not near, but as far remote from the place as it can push the enemy; for a retiring army finds the difficulty of success increased by the distance it is from the place; but if at length the force approaches so near as to furnish a probability of raising it, the besieging corps should rapidly join the covering army, and make an united effort to defeat the enemy.

Logistics.

Logistics in continental armies embrace the practical art of moving corps of troops. It has been questioned whether the term applies solely to details, or whether it forms the general science of all the most essential parts of the art of war; or finally, whether it is simply a vague expression to denote the several branches of the service of the Staff: that is, the application of practical means to adapt the speculative combinations of the art to actual service. The word *Logistique*, in French, is derived from *Logis* (quarters), and therefore was originally applied to the duties we consider to belong to the Quarter-Master-General's department, and thus at first implied castrametation, cantonments, and marches. The late system of war having greatly altered the combinations, the Staff duties became more complicated, and thence resulted the practice to have in each army and corps, a Chief of the Staff, who united in his person, under the General, all the essentials of his office: to him therefore it fell to communicate the intentions of the Commander-in-chief to the most distant parts of the theatre of war, and to procure for him all documents to aid in the formation of his resolutions. Being thus associated with his chief in all the combinations, obliged to transmit and explain them, even watch their execution in general and in detail, his functions necessarily extended to all the transactions of a campaign. Thus the Chief of the Staff was called upon scientifically in all branches of the art of war; and from that time the earlier interpretation of the word *Logistique* became utterly incomplete. The works of A. D. Charles, Guibert, Laroche Aymon, Bousmard, and De Ternay, are insufficient, and an express comprehensive treatise on this subject is become an object well worthy the attention of every Government.*

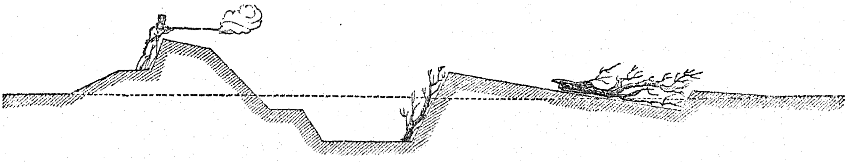
The authorities which have been consulted are chiefly, Guibert; 'Œuvres de Jomini;' 'Traité de Grande Tactique;' 'Guerres de la Révolution;' 'Précis de l'Art de la Guerre;' Lloyd, 'History of the Seven Years' War;' Tempelhoff, 'Geschichte des Sieben-Jährigen Kriegs;' Frederick, 'Histoire de Mon Temps;' 'Art de la Guerre de Main de Maître;' 'Instructions à ses Généraux, Instructions Secrètes;' Rogniat, 'Considérations sur l'Art de la Guerre;' Warnery, 'Œuvres du Général;' Carnot, 'Traité;' 'Die Bellona;' 'Die Minerva;' Scharnhorst, 'Militärisches Taschenbuch;' 'Militärisches Journal;' 'Nähere Beleuchtung des Mack-Zugeschriebenen-Operations-Plan;' Bülow, 'Betrachtung über die Kriegskunst;'

* We were here favoured with an interesting syllabus of the functions of the Chef de l'Etat-Major, such as might have devolved on Berthier, or, latterly, Soult: but this arrangement being so completely at variance with British practice, and being of questionable expediency, the statement given by Colonel Smith has been omitted.—Editors.

'Geist des neuern Kriegs System;' le Prince Charles, 'Principes de la Stratégie,' Vienna; 'Militärisches Zeitschrift;' 'Campagne de 1799;' Dumas, 'Précis des Evènemens Militaires;' Von Gross, 'Hist. Mil. Handbuch für die Kriegs Geschichte, 1792–1808;' Vaudoncourt, 'Campagnes d'Italie en 1813–1814;' Coxe, 'Life of Marlborough;' Pasley, 'Essay on the Military Policy and Institutions of the British Empire;' Jones, 'Journals of Sieges;' Napier, 'History of the Peninsular War;' Ferussac, 'Bulletin des Sciences Militaires;' La Roche Aymon, Gay-de-Vernon, Schmettau, Müller, &c., &c., &c.

A.

ABATTIS should be so placed as not to be exposed to the fire of artillery. In redoubts or intrenchments they are usually fixed in an upright position against the counterscarp, or at the foot of the glacis, the plane of which last is broken so as to permit of their being laid out of the enemy's sight, and so as not to interfere with the musketry fire from the parapet in their rear.



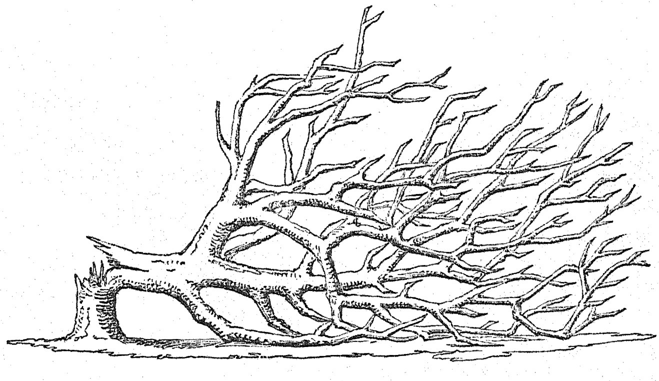
Abattis is an excellent mode of blocking up a road; and when the branches are well and properly placed, and interwoven one within the other, the disengagement of them is extremely difficult; and to form an opening sufficient for the passage of artillery, or even of cavalry, requires a long time to be occupied in so doing. An Abattis can easily be made by a few men, with half-a-dozen felling-axes and a cross-cut saw, and in a short space of time, if trees of sufficient size are near, or on, the spot: it is more easily formed, and gives a more effective defence, than palisades.

An Abattis should not be planted out of musketry range; for this, and all other obstacles, are to break up the order of the enemy's advance; to impede, and to keep him under musketry fire.

The application of the Abattis should be considered as purely local, and not one of the common resources for securing intrenchments, such as palisades, chevaux-de-frize, and fougasses; the materials for the construction of these last being capable of being brought from a distance.

Hence, localities may enable the engineer to obstruct a road by dragging trees from the hedge side; and connecting the defences of a position by levelling groups of trees with their branches towards the enemy.

Shrubby trees are not adapted to form a good Abattis; they are easily forced, and drawn out by the hand; heavy trees, with the trunk cut half through, form insurmountable obstacles: this last is called an *Entanglement.**



* This improvement on Abattis is due to Lieutenant-Colonel Reid, R.E., who used it with success in the Peninsula.

Abattis will always be found a very useful and effective auxiliary to the defence of picquet-houses or isolated posts, if judiciously placed within range of musketry: if placed close in front of the windows on the ground-floor, or to cover the entrance door, it will be extremely difficult for the enemy to force his way into the building.

In field-works it is very often extremely difficult to procure timber to form a barrier to secure the gorge; this may be readily effected if trees are within a short distance of the works, by blocking up the entrance with an Abattis.

ALTITUDE and AZIMUTH CIRCLE.—*Vide* 'Observatory.'

AMMUNITION.

The following Table refers to Sea Service as well as to Land Service Ammunition; the whole being prepared by the Ordnance, chiefly at Woolwich, and supplied for either of the above, as demanded on requisition, Naval or Military.

General Table of the Ammunition of Ordnance, &c., shewing the nature and weight; also the dimensions of the boxes or packing cases usually employed in Stowage and Transport; their weights, empty and filled; contents and numbers, as numbered in the Pattern Rooms at Woolwich.

		Weight of 1.	Number of Contents.	Weight of Box.		Exterior dimensions of Box.			Number in Pattern Room.
				Empty.	Filled.	Length.	Breadth.	Depth.	
		lbs. oz.		lbs.	lbs. oz.	ft. in.	ft. in.	ft. in.	
68-pr.	Grape, quilted	50 8	3		176 8	2 2¼	,, 10¼	1 1½	
	Grape in case	50 15	3		177 13	,, ,,	,, ,,	,, ,,	
	Common shells	42 2	3	25	151 6	,, ,,	,, ,,	,, ,,	
	Round carcass	48 ,,	3		169 ,,	,, ,,	,, ,,	,, ,,	1
	Spherical case	61 4	3		208 12	,, ,,	,, ,,	,, ,,	
	Common case	47 5	3			,, ,,	,, ,,	,, ,,	
	Oblong carcasses . . .		3	28					
	Oblong light balls . .	35 13	3		107 7	2 2¼	,, 10½	1 3½	2
42-pr.	Grape	41 7	4	28	193 12	2 5¼	,, 9	1 1¼	3
	Spherical case	38 2	4		180 8				
	Case, gun	44 ,,	4		204 0				
	Case, carronade . . .	32 13	4	28	159 4	2 5¼	,, 9	1 3¼	4
	Grape, carronade . . .	38 6	4		181 8				
32-pr.	Case, gun	35 1	4	27	167 4	2 2¾	,, 8½	1 2½	5
	Grape, gun	29 13	4	23	142 4	2 2¾	,, 8½	1 0¼	6
	Case, carronade . . .	20 15	4		106 12				
	Grape, carronade . . .	29 8	4	23	141 ,,	2 2¾	,, 8½	1 0¼	7
	Spherical case	29 ,,	4		139 ,,				
	Round carcasses . . .	23 3	4		115 12				
24-pr.	Case, gun	24 2	6	21	165 12	1 7½	1 1½	1 1½	8
	Case, carronade . . .	16 3	6	25	122 2	1 6¾	1 1½	,, 9¾	9
	Grape, carronade . . .	20 ,,	6		142 ,,				
	Grape, gun	20 10	6		145 12				
	Oblong carcasses . . .		6	22		2 4¼	,, 10½	,, 9	10
	Light balls	9 11	6		80 2				
	Flan. cart., 8 lb.	8 2	6		76 12	1 6¾	1 0½	1 3	1 c
	Round shot, strapped .	24 7	6		165 10				
	Case, iron ends, How. .	16 3	6		116 2				
	Carcasses, round . . .	14 3	6	19	104 2	1 7½	1 1½	,, 9	11
	Shells, common . . .	14 15	6		108 10				
	Flan. cart., 2½ lb., How.	2 9	12	24	54 12	2 4¼	,, 10½	,, 9	10 c
5½ in. How.	Spherical case	21 14	6	27	158 4	1 9	1 2½	,, 11	12
	Common case	14 11½	6	22	110 5	1 7½	1 12	,, 10¾	13
18-pr.	Case, gun	19 11	8	23	180 8	1 10¾	1 0¼	1 0¾	14
	Case, wood ends . . .		8						
	Round, strapped . . .	18 6	8	20	167 ,,	1 10¾	1 0½	,, 9	15
	Carcasses, round . . .	11 13	8		114 8				
	Spherical case	15 11	8	24	149 8	2 1¼	1 1¼	,, 9	16
	Grape, carronade . . .	15 8	8		144 ,,				
	Grape, gun	16 12	8	20	154 ,,	1 10¼	1 0¼	,, 10½	17
	Flan. cart., 6 lb. . . .	6 1½	8	25	73 12	1 10¼	1 1	1 2	2 c

TABLE—*Continued.*

		Weight of 1.	Number of Contents.	Weight of Box. Empty.	Weight of Box. Filled.	Exterior dimensions of Box. Length.	Exterior dimensions of Box. Breadth.	Exterior dimensions of Box. Depth.	Number in Pattern Room.
		lbs. oz.		lbs.	lbs. oz.	ft. in.	ft. in.	ft. in.	
12-pr.	Case, gun S.S.*	11 14	12		168 8				
	Grape, gun	11 1	12		158 12				
	Grape, carronade	10 9	12	26	152 12	2 5½	,, 11¼	,, 10½	18
	Case, carronade	8 4	12		125 ,,				
	Case, howitzer	11 8	12		164 ,,				
	Round, strapped	12 8½	12		174 ,,				
	Carcasses, round	8 4	12	24	123 ,,	2 5½	,, 11	,, 8½	19
	Shells, common	8 8	12		126 ,,				
	Spherical case, gun	10 14	12	25	155 8	2 8½	,, 11½	,, 6½	20
	Spherical case, how.	10 ,,	12		145 ,,				
	Case, Land Service gun	17 4	6	17	120 8	1 3¼	,, 11¼	1 0¼	21
	Case, Howitzer or 4⅖	8 4	12		120 ,,				
	Carcasses, oblong		12	21		2 5¼	,, 11¼	,, 9¾	22
	Light balls	5 4	12		84 ,,				
	Fl. car., gun, 4 lb.	4 1	12	26	74 12	2 4¼	,, 10¾	1 0¾	3 c
	Fl. car., how. 1 lb. 4 oz.	1 5	36	27	74 4	2 0¼	1 0¼	1 1½	11 c
	Fl. car., how. 1 lb. 14 oz.	1 15	24	24	70 8	2 2¾	,, 10½	1 1	12 c
9-pr.	Case, gun	13 2	12	23	180 8	2 3	,, 10½	,, 11½	23
	Grape, gun	8 12	12		128 ,,				
	Case, gun S.S.	9 10	12	23	138 8	2 3	,, 10½	,, 10	24
	Grape, carronade	9 1	12		131 12				
	Round, strapped	9 2	12	18	127 8	2 3	,, 10½	,, 7½	25
	Case, carronade	6 7½	12		95 10				
	Spherical case	8 2¼	12	23	120 11	1 4½	,, 11¼	1 2	26
	Flan. cart. gun, 3 lb.	3 1	12	23	59 12	2 1½	,, 10½	,, 11¾	4 c
6-pr.	Round, strapped	6 1½	24	24	170 4	2 0½	,, 9¼	,, 11¾	27
	Case L.S.†	8 13	12		139 12				
	Case S.S.	5 10	24	23	158 ,,	2 6½	1 1	,, 8¾	28
	Grape S.S.	5 6	20		130 8				
	Case, carronade	4 9	20	23	114 4	1 8¼	,, 9¼	1 2½	29
	Grape, carronade	5 2	20		125 8				
	Spherical case	5 7½	24	29	160 4	2 3¾	,, 10	1 ,,	30
	Flan. cart., 2 lb.	2 1	24	31	80 8	2 6¼	1 ,,	,, 11½	5 c
	Flan. cart., 1½ lb.	1 9	24	28	65 8	2 6¼	1 ,,	,, 9½	6 c
3-pr.	Round, strapped	3 1	30	18	109 14	1 4¾	,, 10¾	,, 10½	31
	Case, L. or S.	4 3½	30	25	151 9	2 6¼	,, 10½	,, 8¾	32
	Grape, gun	2 9	30		101 14				
	Fl. cart., 1 lb.	1 0½	30	26	56 15	2 6¼	,, 10¼	,, 10	7 c
	Fl. cart., 12 oz. fixed to rd. shot	3 13½	12	21	67 2	1 7¼	,, 11½	1 ,,	8 c
	Fl. cart., 12 oz. fixed to case shot	5 ,,	12	24	84 ,,	1 7¼	,, 11½	1 2½	9 c
2-pr.	Case	2 4	60	26	161 ,,	2 3	1 2½	,, 7¾	33
1½-pr.	Case	1 12½	50	19	108 1	2 ,,	1 1	,, 7¼	34
1-pr.	Case	1 8	50	15	90 ,,	1 9¾	,, 11¾	,, 8¾	35
	Round, strapped	1 1	50	15	68 2	1 ,,	1 ,,	,, 9	36
13-in.	Shells	192 2	1	29	221 2	1 3¾	1 3½	1 4	37
	Carcasses, round	210 ,,	1		239 ,,	1 3¾	1 3½	1 4	
10-in.	Shells	85 3	2	26	196 6	1 10¾	1 0½	1 1	38
	Carcasses, round	98 2½	2		222 5				
	Case, shot	85 6	2		204 12				
	Carcasses, oblong		2	34		1 10¾	1 0½	,, 6½	39
	Light balls	76 8	2		187 ,,				
Bursters.	15 oz.	,, 15½	36		49 10				
	10	,, 10½	48		52 8				
	7½	,, 8	60		51 ,,				
	7	,, 7½	60		49 2				
	6	,, 6½	60	21	45 6	1 8¼	,, 11	1 0¾	13 c
	5	,, 5½	72		45 12				
	4½	,, 5	72		43 8				
	3½	,, 4	96		45 ,,				
	2½	,, 3	120		43 8				

* S.S. Sea Service. † L.S. Land Service.

In estimating stowage for the above, an allowance must be made, in addition to the length, of 2½ inches, for the two cleats at the ends, through which the rope handles are fixed.

The cartridge boxes which are marked C are made with copper nails.

Memorandum.—For Sieges, the powder is occasionally sent as above, but far more generally in barrels.

Sea Service Magazine Boxes, lined with tinned copper.

		Length. ft. in.	Breadth. ft. in.	Depth. ft. in.	Weight. Empty. lbs.	Weight. Filled. lbs.
Correspond to 1, ½, and ¼ powder barrels in contents.	Whole boxes	1 4¾	1 4¾	1 9	46¼	136¼
	Half do.	1 1½	1 1½	1 4⅝	29	74
	Quarter do.	0 10⅛	0 10⅛	1 1¾	17½	40

The powder usually packed in these cases is made up in flannel cartridges, and marked for their respective ordnance: when not thus definitely allotted, it is packed in bags of 15 lbs., of which the whole box contains 6, or 90 lbs.

Small-Arm Ammunition.

		Powder Drs.	Balls per lb.
	Wall piece	10	7
Percussion	Musket-ball-cartridge for muskets of all patterns,—Guards, Line, Line Serjeants, or Navy	4½	14½
Percussion	Rifle, and Guards Serjeants' rifled musket	2½	12½*
Percussion	Rifle,—Navy, heavy	3½	8 nearly.
Percussion	Carbine,—Victoria, Ordnance Corps, and Cape Corps 2 bar[d].	3½	14½
Percussion	Carbine,—Constabulary	2½	14½
Percussion	Pistol, Navy	2	34
	Pistol, as partially retained in the Cavalry, heavy	3½	14½
	Pistol, as partially retained in the Cavalry, light	3	20
	Blank cartridge for all	„	3½

The nipple and cap are the same for all Arms; five caps are supplied for every four cartridges; rifles are loaded with a blank cartridge, ball, and grease-patch.

Rifle ammunition, in dark green paper; ball-cartridge, in white; and blank, in blue.

Ball-cartridge Box for the Field Service Ball-cartridge Waggon.

		Cartridges.	Percussion caps.	Weight, filled. lbs.	Exterior dimensions.	ft. in.	
Percussion	Musket	1000	1250	106	Length	1 3½	Weight empty, 13 lbs.
	Rifle	1080	1350	115¼	Breadth	0 7¾	
	Victoria carbine	1190	1487	115	Depth	1 5¾	

The ball-cartridge box has only one cleat, ¾ inch thick, and it is on the bottom; in estimating stowage for this box, therefore, the allowance must be made in addition to the depth.

* The *bore* is for 14½; but the belt on the ball gives the additional weight. As taken from actual measurement, the 14½ bore is ·75 in., and the diameter of the ball ·68 in.

ANEMOMETER (*Wind Measure*), Wind Guage.*

It is not intended to do more in this article than describe some ordinary instruments and modes of observation, in such a manner, that an Officer, wherever his duties carry him, may be enabled to render useful service. The general phenomena of winds, and the place they bear in meteorological science, must be sought in works more exclusively devoted to the subject. It may, however, be briefly stated, that we are to consider wind as the movement of the aërial ocean which envelopes our globe, subject to the laws of fluid matter, and acted on by physical causes, which, though extremely variable, are all more or less reducible to fixed laws.

The most influential cause of aërial currents is change in the density of the air, from changes of temperature. Some of the currents so produced are general, as the trade-winds in the tropical, and their counter currents in the temperate, regions of the globe, with the various translations and oscillations to which they give rise; some local, as land and sea breezes: these latter, indeed, sometimes possess a very extensive character, and embrace considerable range, as the monsoons of the Indian Ocean. The quantity and tension of aqueous vapour is also very important, from its influence on the density and pressure of the air; and the electrical condition of the atmosphere is well known as a fertile, and often terrific, cause of wind. The theory of Hurricanes still requires much observation, before philosophers can determine to what cause the phenomena of revolving gales are really attributable. It is not improbable, that the general aërial waves may revolve around nodal points as those of the ocean do. It is also very important to notice whether a gale begins to windward or to leeward, *i. e.* whether the air is propelled, or whether it is sucked into a vacuum.

These are merely indications of the objects to be considered. By such considerations, and others which will readily occur to the intelligent observer, he will arrange his instruments and observations with a view to the peculiar circumstances of his position, so as to afford the class of information which may best elucidate the changes shewn by his Anemometer.

The elementary facts we require to know in relation to the wind, are its *direction*, and its *force*, or *velocity*.

The *direction* of the wind is measured by the ordinary vane, and may be read either by direct observation, or by the vane being made to move the hands of a dial. There is an instrument for this purpose called an Anemoscope. The notation commonly used is that of the seaman's compass, but it is sometimes written in degrees of a circle. On this system N. 30° E., for example, means 30° to the eastward of north. The following Table is from Riddell's 'Magnetic Instructions,' p. 131.

Direction.		Corresponding Azimuths.					Direction.		Corresponding Azimuths.				
N.	=	0	0	..	360°	0′	S.S.W.	=	202	30	..	157	30
N.N.E.	=	22°	30′	..	337	30	S.W.	=	225	0	..	135	0
N.E.	=	45	0	..	315	0	W.S.W.	=	247	30	..	112	30
E.N.E.	=	67	30	..	292	30	W.	=	270	0	..	90	0
E.	=	90	0	..	270	0	W.N.W.	=	292	30	..	67	30
E.S.E.	=	112	30	..	247	30	N.W.	=	315	0	..	45	0
S.E.	=	135	0	..	225	0	N.N.W.	=	337	30	..	22	30
S.S.E.	=	157	30	..	202	30	N.	=	360	0	..	0	0
S.	=	180	0	..	180	0							

* By Capt. Larcom, R.E.

The *force* of the wind is estimated by its pressure on a given surface, usually the pressure per square foot. Various instruments have been devised for measuring it directly; as, for example, by connecting with a board a foot square, some simple apparatus, moving a weight over a pulley; or a spring whose strength has been estimated; and the indications of these instruments, as well as those last described, may be read on a dial. So, also, by the revolutions of a set of wind-mill vanes, weights or counterpoises may be moved, or balls projected outwards on a slide, by the centrifugal force communicated to a vertical spindle,—or, like the well-known regulator of motion in machines, called a 'governor.' Any of these, if kept in good order and carefully observed, will furnish useful indications. There is one differing from these, but so simple and portable that it may be worth while to describe it. LIND'S *Anemometer* (Plate I. fig. 1) is a bent tube of glass, to be half filled with water, of which the neck, or bent portion, is very narrow, in order to check the motion of the water. As they are made in the shops, the vertical parts of the tube are 8 inches, and $\frac{1}{4}$th of an inch in diameter. A scale is fixed between them, graduated in inches and tenths. One tube has a brass cap (*a*) turned at right angles, and open; this orifice is kept facing the wind by a vane (*b*), the whole swinging by swivels on an axis, which may be fixed on any staff or other support. The other tube also terminates in a brass cap (*c*), having only a small hole in it to admit air. Water is poured in till it stands at the zero of graduation in both tubes. When the orifice is now presented to the wind, the water is of course forced down in the one tube, and rises in the other. The difference shewn by the scale will be the height of a column of water whose weight is equal to the force of the wind. And, as a cubic foot of water weighs 1000 ounces, a stratum of water of a foot square, and 1 inch deep, will weigh $\frac{1}{12}$th of 1000 ounces, or $5\frac{1}{5}$ ℔s. nearly, which is obviously the pressure of an inch of water on a square foot of surface. A rise, therefore, of 1 inch in the tube of this instrument, indicates a pressure of $5\frac{1}{5}$ ℔s. in the square foot, which is the force of the wind at that time, and so on.

The *velocity* of the wind may be measured directly, or it may be deduced from its force. Rough indications of velocity may be obtained by merely noticing the shadows of clouds, or by the flight of balloons, but these all give obviously the currents only of the upper air, and belonged to the infancy of science. A very simple contrivance has been used by Mr. Snow Harris, which he thus describes: "A cork, stuck round with capacious feathers, is made to travel over a fine wire of a given length by the force of the wind. The cork is set on a common writing quill, bushed with a small brass plate at each end, by which the whole is supported on the wire, fine holes being drilled through the brass plates for receiving it. This contrivance is extremely light, and will fly along the wire with the velocity of the wind, or very nearly so, for a given distance. It is in fact, throwing, as it were, a log-line on the air."

Or, the velocity may be deduced from the force, for which purpose a series of experiments was made at Woolwich by Dr. Hutton, who, as might be expected, found the force nearly proportional to the square of the velocity, being of course the same as that opposed to a body moving through a medium, the only difference being, that in this case the body is at rest and the air in motion. By those experiments he found a velocity of 20 feet per second equal to a pressure of 12 ounces on a square foot, from which he deduced a Table for Dr. Lind's Anemometer, which has been subsequently corrected by Mr. George Harvey, from whose paper in the Encyc. Metrop. it is here copied, with some extensions.

Table shewing the Force and Velocity of the Wind, &c.

Height of the Column of Water.	Force of the Wind on a square foot.	Velocity of the Wind per hour.	Common designation of such a Wind.
In Inches and Decimals.	In Avoirdupois Pounds.	In Miles and Decimals.	
0·05	0·26	8·0	A pleasant wind (light breeze).
·10	0·52	11·3	A fresh breeze.
·15	0·78	13·9	
·20	1·04	16·0	
·25	1·30	17·9	
·30	1·56	19·6	
·35	1·82	21·7	
·40	2·08	22·7	
·45	2·34	24·1	
·50	2·60	25·4	A brisk gale.
·55	2·86	26·6	
·60	3·12	27·8	
·65	3·38	28·9	
·70	3·64	30·0	
·75	3·90	31·1	
·80	4·16	32·1	
·85	4·43	33·1	
·90	4·69	34·1	
·95	4·94	35·0	
1·00	5·21	35·9	A high wind.
1·50	7·81	44·0	
2·00	10·42	50·8	A very high wind.
2·50	13·02	56·8	
3·00	15·62	62·2	A storm.
3·50	18·22	67·2	
4·00	20·83	71·8	A great storm.
4·50	23·43	76·2	
5·00	26·04	80·4	A very great storm.
5·50	28·89	84·6	
6·00	31·75	88·7	A hurricane.
6·50	34·15	92·0	
7·00	36·55	95·2	A great hurricane.
7·50	39·10	98·5	
8·00	41·66	101·6	A very great hurricane.
9·00	46·87	108·0	Most violent hurricane.
10·00	52·08	113·6	
11·00	57·29	119·2	
12·00	62·5	124·0	

In violent winds a heavier fluid, even mercury, may be used; or, in great degrees of cold, a saturated solution of sea salt has been recommended. In either case the figures which denote the force in the above Table must be multiplied by the specific gravity of the fluid employed.*

But our knowledge of the aërial currents would have made very slender advances from individual observations alone, however numerous, and much ingenuity has accordingly been exerted in the contrivance of self-registering instruments. The two which at present divide the opinion of philosophers are those invented by Mr. Whewell in 1835, and Mr. Osler in 1836.

The object of the former is thus stated by the inventor, viz. "To obtain a record of

* On one of the mountain stations of the Trigonometrical Survey of Ireland, 2469 feet above the sea, the water was completely blown out of Lind's Anemometer; the force, therefore, amounted to 41·7 in the square foot, and the velocity 101 miles an hour, at the moment the whole of the water was driven into and sustained in the further leg, after which it must have increased considerably, though it had escaped beyond the limits of the instrument to measure.

the total *amount* of the aërial current which passes the place of observation in each direction. The assemblage of such records for any given time will exhibit a *type* of the course of the wind for such time; the mean of such records at the same place, for different years, will exhibit the *annual types* of the winds for that place; and the comparison of the types of the winds for many different places will throw light upon the general annual movement of the atmosphere." It is thus described: "It consists of a small wind-wheel, like a wind-mill with eight sails,* which is kept towards the wind by a vane. The rapid rotation of this wheel is by a train of toothed wheels and screws, converted into a slow vertical motion, one-twentieth of an inch being the descent produced by 10,000 revolutions of the wheel, which motion carries a pencil downwards, tracing a line on the surface of a vertical cylinder, having the axis of the vane for its axis. The extent of vertical motion shews the amount of the wind, and the part of the circumference of the cylinder, on which the trace lies, shews the direction."

This will readily be understood by inspection of fig. 2, Plate I., which exhibits an instrument of this kind, erected at the Ordnance Survey Office, near Dublin, together with figs. 3 to 14, Plates I. and II., which shew the details of contruction, as given by Mr. Snow Harris, in the 'Transactions of the British Association for 1842.' In the Dublin instrument, instead of the pencil marking the course on the cylinder itself, to be rubbed off every time the pencil reaches the bottom, there is a paper ruled exactly like the cylinder, lapped around it, and pasted together at the edges. When the pencil has descended to the bottom, the paper is replaced by a new one. A series of such papers, afterwards joined into one length, forms an actual field-book, as it were, of the wind for any length of time.

In order to determine the absolute velocity of the aërial current from this instrument, a series of experiments was made by Mr. Snow Harris, from which he arrived at the following deductions:

1st. "When the pencil tracing the integral effect of the wind moved by the revolutions of the fly at the rate of one division of the scale of measure, or ·1 of an inch per hour, the current of air for the same time moved at a mean rate of 11 feet per second."

2nd. "The space described by the pencil appeared to be proportional to the square of the velocity of the aërial current acting on the fly. Thus, when the pencil described four divisions of the scale in an hour, the velocity, by a mean of many observations, amounted to 22 feet in a second. When the velocity was 15 feet in a second, the pencil had described about two divisions of the scale in an hour, and so on. Having, then, the velocity due to a given rate of indication per hour taken as unity, it is easy to find the velocity due to any other rate of indication, since we have only to multiply the square root of the given rate by the constant 11, the velocity per second corresponding to a space of one division of the scale."

By this rule, the mean velocity of wind, as indicated by this instrument at Plymouth, between April, 1841, and April, 1842, was 13·16 feet per second, or about 9 miles per hour. The actual velocity being thus obtained, the force may be deduced from it by Hutton's Table, p. 37. But if the descent of the pencil be proportional to the square of the velocity, it is of course at once a measure of the force without the intervention of velocity. These deductions must, however, be received with great caution, because it is obvious the descent of the pencil ought to be *directly* proportional to the velocity, and it can only be rendered otherwise by friction, an element so variable, that separate experiments are necessary for every individual instrument.

Osler's Anemometer is thus described by its inventor. "*The direction* of the wind is obtained by means of the vane attached to the rod, or rather tube, which carries it,

* No specific direction for the sails is given. The best would appear to be about 55°, the maximum angle for the sails of a wind-mill.

and consequently causes the latter to move with itself. At the lower extremity of this tube is a small pinion, working in a rack, which slides backwards and forwards as the wind moves the vane, and to this rack a pencil is attached, which marks the direction of the wind on a paper ruled with the cardinal points, and so adjusted as to progress at the rate of an inch per hour, by means of a clock. The force is at the same time ascertained by a plate one foot square, placed at right angles to the vane, supported by two light bars running on friction rollers, and communicating with three spiral springs in such a way that the plate cannot be affected by the wind's pressure without instantly acting on this spring, and communicating the quantum of its action by a light wire passing down the centre of the tube to another pencil below, which thus registers its degree of force."

This instrument also has attached to it an additional apparatus for registering the rain.

In the Meteorological Instructions recently published by the Royal Society, especial attention is directed to the following points regarding wind:

1st. "Its average intensity and general direction during the several portions of the day devoted to observation."

2ndly. "The hours of the day or night when it commences to blow from a calm, or subsides into one from a breeze."

3rdly. "The hours at which any remarkable changes of its direction take place."

4thly. "The course which it takes in veering, and the quarter in which it ultimately settles."

5thly. "The usual course of periodical winds, or such as remarkably prevail during certain seasons, with the law of their diurnal progress, both as to direction and intensity; at what hours, and by what degrees they commence, attain their maximum, and subside; and through what points of the compass they run in so doing."

6thly. "The existence of crossing currents at different heights in the atmosphere, as indicated by the courses of the clouds in different strata."

7thly. "The times of setting-in of remarkably hot or cold winds, the quarters from which they come, and their courses, as connected with the progressive changes in their temperature."

8thly. "The connection of rainy, cloudy, or fair weather, with the quarter from which the wind blows, or has blown for some time previously."

A few words may be necessary on the modes of reducing and digesting the recorded results of an Anemometer, though none have been finally determined as applicable to all. The observations of Mr. Whewell's instrument are reduced in a particular manner for the purpose of ascertaining the *integral effect* of the wind, *i.e.* the amount and direction of aërial fluid which finally proves to have passed over the place of observation at the end of a year, or any other period. First, by resolving each partial wind into its component parts E. and W. and N. and S. Then from the sum of all the W. components, subtracting the E. elements, which gives the effective W. winds, and from the sum of all the S. components, subtracting the N. elements, which gives the effective south winds. The magnitude and proportion of these two effective winds compounded give the magnitude and direction of the *effective wind*, or amount of air which has been *on the whole* transferred across the place of observation during the whole term of observation. This reduction is performed by considering each wind as the hypothenuse of a right-angled triangle, and finding the natural sine and cosine of each, which, used as multipliers, will give its value in the required direction. Thus the four inter-cardinal winds, N.E., &c., are reduced to the cardinal directions by multiplying by $\frac{7}{10}$. The eight subordinate winds, N.N.E., &c., have for multipliers $\frac{12}{13}$ and $\frac{4}{10}$. Thus a wind N.N.E. 65 is equivalent to N. 60 and E. 26. The oblique winds have for their multipliers $\frac{2}{10}$ and $\frac{98}{100}$; and for the remaining points $\frac{55}{100}$ and $\frac{83}{100}$ may be used, but such minuteness can seldom be necessary.

Indications of Whewell's Anemometer.

JANUARY, 1837.

1	N. 12	Total. 12	12	N. 2 N.E. 0	Total. 2	22	S.S.E. 45	Total. 45
*2	N.N.W. 8 S.W. 1	9	*13	S.S.W. 45 S.W. 9	54	*23	S. 22 S.S.W. 34	56
3	W. 7	7	14	S.W. 11 N.W. 58	69	24	S.S.W. 44 S.W. 10	54
4	S.W. 11	11	*15	N.N.W. 56	56	25	S.W. 7 E. 8	15
5	S.W. 11	11	16	N.N.W. 7 W.S.W. 2	9	*26	E.N.E. 44	44
6	S.S.W. 28	28	17	S.W. 2 W.N.W. 1	3	27	E.N.E. 65	65
*7	S.W. 51	51	18	N.W. 0	0	*28	E.N.E. 48	48
8	W.S.W. 29	29	19	E.N.E. 0	0	29	N.E. 34	34
9	S.S.W. 26	26	20	E.N.E. 12	12	30	E.N.E. 10 S.E. 15	25
*10	S.S.W. 76	76	21	S.S.E. 6	6	*31	S.S.E. 48	48
11	S.W. 13 N. 25 W.N.W. 4	42						

FEBRUARY.

1	S.S.E. 5 S. 5 S.S.E. 8	Total. 18						
2	S. 2	2						
3	S.E. 14	14						
4	S.E. 30	30						
5	S.E. 17 S.S.E. 10	27						
6	S.S.E. 29	29						
7	S.S.E. 31 S. 7	38						

* The asterisk indicates the times when the instrument was wound up.

Reduction of the Indications of the Anemometer.—1837.

	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	N.
Jan. 1 to 14.	12		0							28	1	29	7	4		8	
1 14	25									26	11						
N. S.W.	2									76	11						
12 11										45	51						
											13						
											9						
											11						
	39									175	107	29	7	4		8	
S.S.W.									162				70				
S.W.									75				75				
W.S.W.									12				27				
W.N.W.	1												4				
N.N.W.	7												2				
	47								249			W.	185				
								N.	47								
								S.	202								
Jan. 14 to 20.				12							2	2		1	58	56	
14 20																7	
N.W. E.N.E.																	
58 12				12							2	2		1	58	63	
E.N.E.	5				11				1				1				
S.W.									0				2				
W.S.W.													1				
W.N.W.	0												41				
N.W.	41												25				
N.N.W.	58																
	104												70				
S.	1											E.	11				
												W.	59				
N.	103																
Jan. 21 to 25.								6	22	34	10						
21 25								45		44	7						
S.S.E. S.W.								51	22	78	17						
6 7																	
S.S.E.					20												
S.S.W.									47				31				
W.S.W.									72				16				
									7				47				
								S.	148			E.	20				
												W.	27				
Jan. 26 to 30.			34	44	8												
25 30				65													
E. E.N.E.				48													
8 10				10													
			34	167	8												
N.E.	24				24												
E.N.E.	65				154												
N.	89			E.	186												
Jan.30—Feb.7.							15	48	5								
S.E. S.							14	5	2								
15 7							30	8	7								
							17	10									
								29									
								31									
							76	131	14								
S.E.					53				53								
S.S.E.					52				121								
					105			S.	188								

Summary.

	N.	E.	S.	W.
Jan. 1 to 14 . .	. . .	. . .	202	185
,, 14 ,, 20 . .	103	. . .	. . .	59
,, 21 ,, 25 . .	. . .	. . .	148	27
,, 26 ,, 30 . .	89	186	. . .	. . .
,, 30 ,, Feb. 7 .	. . .	105	188	. . .
	192	291	538	271
			192	291
			S. 346	E. 20

Various modes have been devised of exhibiting graphically the results of wind observations. The most simple is to plot the course like a traversed survey; *i.e.* starting from a given point, draw a line in the direction of the first recorded wind, of such a length as represents its magnitude. From the extremity of this line draw another, representing the direction and magnitude of the second recorded wind, and so on; or, lines may be drawn radiating from a centre to all the points of the compass, each line being made of length proportioned to the magnitude it records, whether of prevalence or of force. The extremities of the lines being joined, a polygon is formed, it may be for a month. The comparison of polygons formed from several recurrences of the same month will give a type of that month, and their combination a type of the year. The same may be expressed by curves formed from ordinates and abscissæ, or in various ways suitable to particular purposes, which it is not necessary to dwell on.

There is one mode, however, so ingenious, that it deserves especial mention. It is that devised by M. Léon Lalanne for exhibiting three variables. It will easily be understood by considering that we can fix any point on a plane by the intersection of two co-ordinates; and if we suppose each of these co-ordinates to represent a variable, and a perpendicular to be erected on that point, of such a length as shall represent the third, we shall have a net-work of squares, and from every intersection a perpendicular projecting upwards: the summits of these perpendiculars, varying in length, will represent, as it were, the surface of a model of ground. But the difficulty remains of exhibiting on the plane of the base the position which the summit of the perpendicular occupies in space. This difficulty, however, is precisely the same as that felt in representing the undulations of ground in a plan; and the application of contours, so successful in the latter, is equally descriptive in the former. Suppose we desire to exhibit the prevalence of particular winds at particular places for each month of the year; say at Dum Dum, near Calcutta. (Plate III. fig. 15.) [This is the example given by M. Lalanne.] The winds range up the sides of the rectangle, the months at its top and bottom; the imaginary lines perpendicular to the plane indicate the proportional prevalence of the winds in each month, their height being represented by figures of altitude, and all those which are equal being joined to form the curves, or contours. In this figure M. Lalanne has chosen to divide the month into twentieths. Following now the vertical line which indicates the month of September, for instance, till we come to the horizontal line marked East, we find ourselves on a contour marked 4, which indicates that during $\frac{4}{20}$ or ·2 of the month of September the wind was easterly, and so on. A curve constructed of abscissæ and ordinates in the usual way would obviously be analagous to *a section* of the ground of which the figure of M. Lalanne may be considered for the moment a topographic representation, but a separate curve must be made for each month to afford the same information.

Fig. 1.

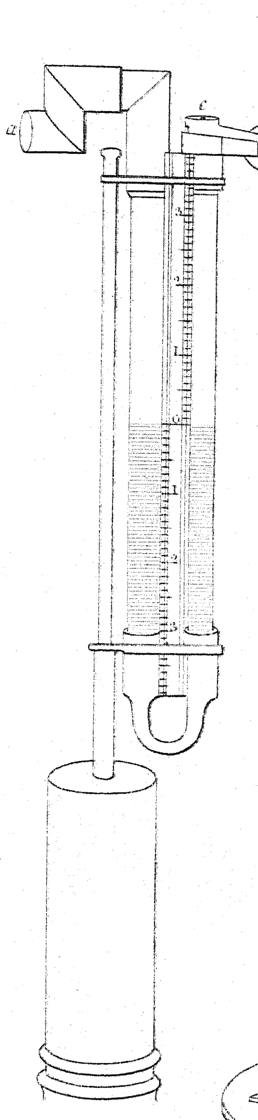


Fig. 2.

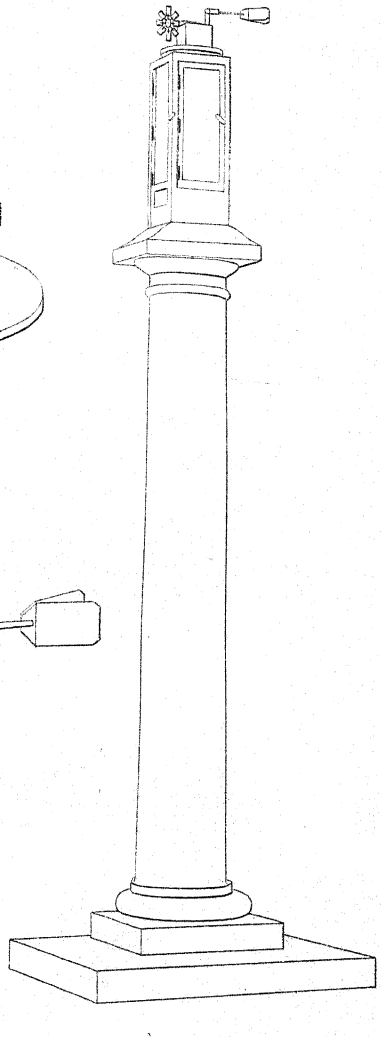


Fig. 3.

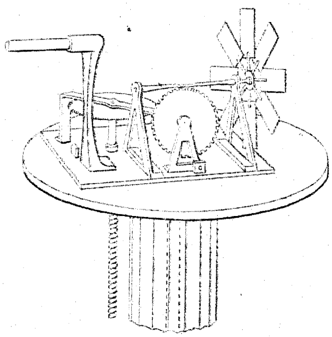
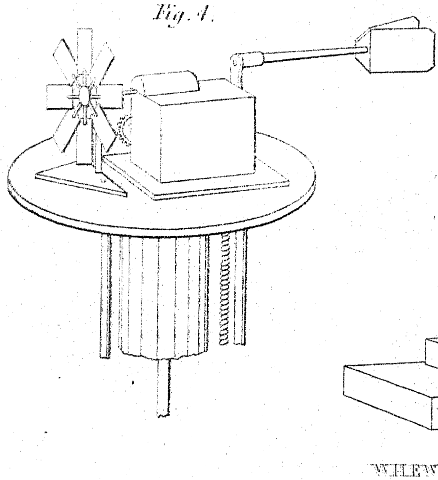


Fig. 4.



LIND'S ANEMOMETER

Scale of 1/3

WHEWELL'S ANEMOMETER.

Scale of 1/30

s

c

Fig. 5.

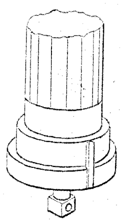


Fig. 6.

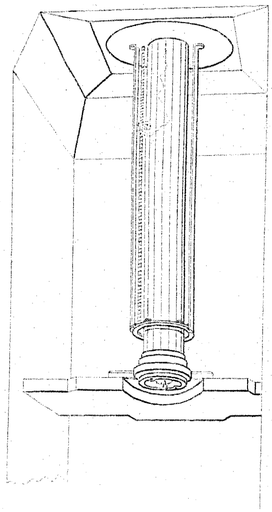


Fig. 7.

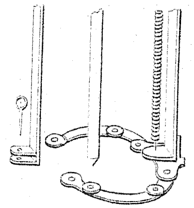


Fig. 8.

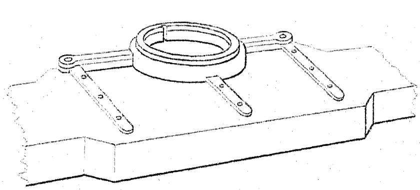


Fig. 9.

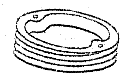


Fig. 10.

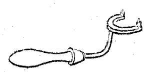


Fig. 11.

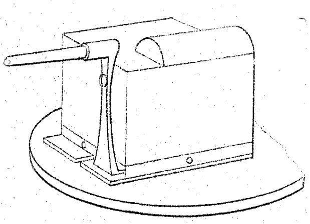


Fig. 12.

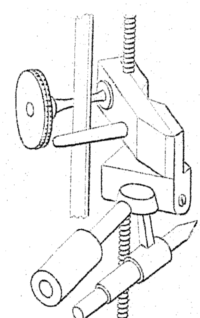


Fig. 13.

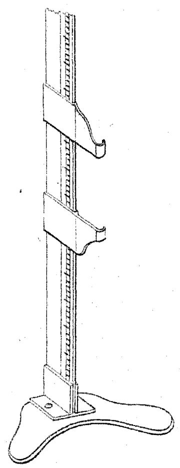


Fig. 15.

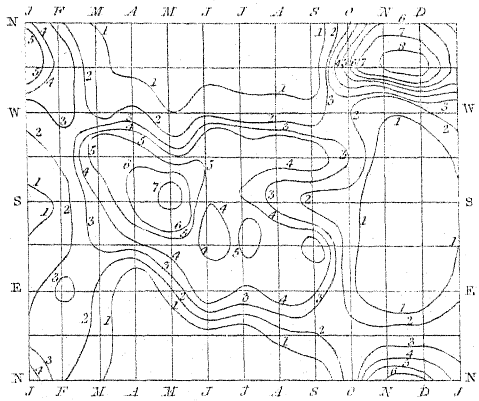


Fig. 16.

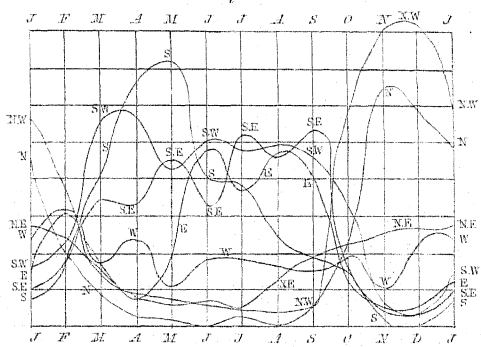


Fig. 14.

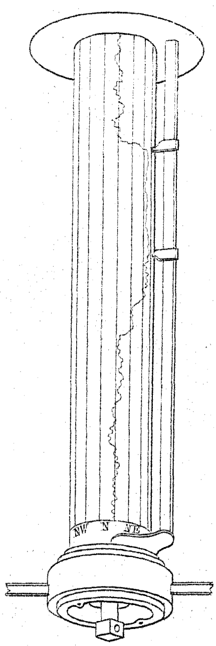
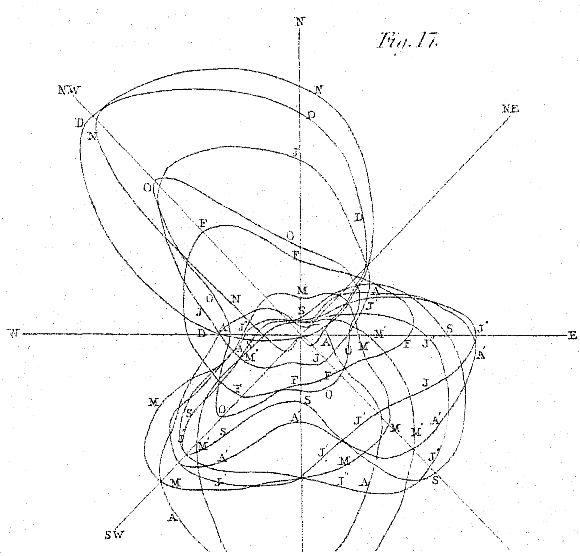


Fig. 17.



In like manner the polygons before mentioned might, by constructing one for each month, be made to represent the same thing. (Plate III. fig. 17.) This latter, indeed, is analogous to a topographic projection on polar co-ordinates, but either of these modes would obviously be far more complicated, and less graphic, than this most ingenious contrivance, which is, besides, susceptible of various other applications and extensions.

ANTI-CORROSION, as applied to Iron Traversing Platforms, Gun Carriages, and outsides of Guns.

44 oz. anti-corrosion. 4 oz. Grant's black. 2 oz. red-lead. ¼ gal. linseed oil. $\frac{1}{16}$th pt. spirits of turpentine.	To be well mixed, and laid on immediately; as it becomes useless from its hardening into a cake.

Anti-corrosion.—Quantities for Ordnance, &c., two coats.

Guns. pr.	ft.	lbs.	oz.	Carronades. pr.	lb.	oz.	Mortars.	lbs.	oz.	Bed.
32	9½	3	1	32	1	0	13-inch Sea	2	8	
24	9½	2	7	24	0	9½	10 „ „	1	1	
18	9	1	10	18	0	8	13 „ Land	0	12	2 1
							10 „ „	0	9½	1 6
							8 „ „	0	6	1 1

Iron Carriages average 4¾ lbs., and Traversing Platforms 14¼ lbs.

The bores are lacquered with the following:

36 oz. Cumberland black-lead. 1 gal. linseed oil. 10 oz. red-lead. 1 oz. lamp-black.	To be well ground into the oil, and then boiled slowly till thoroughly incorporated.

R. J. N.

APPROACH.—*Vide* 'ATTACK OF FORTRESSES.'

APPROACH, COUNTER.—*Vide* 'DEFENCE.'

ARMAMENT.—*Vide* 'ARTILLERY' and 'DEFENCE.'

ARTILLERY.*—This subject was only undertaken after a distinguished Officer of Artillery had declined to contribute the Article; and it is given for the use of the Army in general, and in explanation of the several Tables which have been supplied through the kindness of the Officers of the Artillery Departments.

'Artillery,'—in the British Service, comprehends every branch of that part of the Army, and includes *Matériel*, as well as *Personnel*, besides the constructive and scientific departments.

Foreign Artillery, *Marine Artillery*, (or *Armament of Ships of War*,) and the *Theory of Artillery or Gunnery*, and '*Equipment*,' are explained as they occur alphabetically in separate articles.

* By Colonel Lewis, R.E.

SECTION I.

The constituent subjects of 'Artillery' may be concisely stated as follows:

- ARTILLERY.
  - Personnel
    - Horse Artillery.
    - Rocket ditto.
    - Foot ditto.
    - Invalid Gunners.
    - Master Gunners.
  - Matériel
    - Ordnance
      - Iron
        - Guns.
        - Howitzers.
        - Mortars.
        - Carronades.
      - Brass
        - Field guns.
        - Do. howitzers.
        - Small mortars.
      - Rocket
        - Field.
        - Heavy.
    - Carriages
      - Travelling
        - Field.
        - Siege.
      - Standing
        - Wood.
        - Iron.
      - Waggons, &c.
    - Ammunition
      - Powder.
      - Shot.
      - Shells.
      - Case or canister.
      - Grape.
      - Spherical case.
    - Stores in general.
  - Instruction
    - Academical
      - Mathematics.
      - Fortification. } Theoretical.
      - Gunnery } Theoretical.
      - Languages.
    - Practical
      - Fabrication and Construction
        - Manufacture of powder.
        - Do. of other laboratory stores.
        - Foundry and Proof departments.
        - Carriage department.
      - Elementary Tactics
        - Repository course.
        - Field battery exercise.
        - Gun, mortar, howitzer, and rocket practice.
        - Infantry drill, and other exercises of arms.

These several branches are under the control of the Master-General and Board of Ordnance; more especially as regards the Finance and Matériel.—The Personnel is under the immediate orders of the Master-General.

SECTION II.

The administration of the Artillery (subject to the Master-General and Board of Ordnance) is distributed among the following departments; the head-quarters being at Woolwich.

1. The Personnel, under a Deputy-Adjutant-General.
2. The Equipment, under a Director-General of Artillery.
3. The Stores, before and after conversion, are under the control of a Principal Storekeeper.
4. The construction and fabrication of Stores are executed by the
   Laboratory Department.
   Carriage Department.
   Foundry Department.
5. The Theoretical branch for Cadets is under a Lieut.-Governor in charge of the Royal Military Academy.
6. And the Practical Course of Instruction is given under the direction of the above-named Departments, besides the most necessary practical duties taught in the Repository.

Referring to the preceding heads:

1. The Personnel of the Effective force forms one regiment of Royal Artillery, divided into battalions and troops, according to the exigency of the service: the minimum Peace Establishment being six troops of Horse Artillery and nine battalions of eight companies of Foot Artillery; and the maximum force has been, as a War Establishment, equal to fourteen troops of Horse Artillery, ten battalions of ten companies of Foot Artillery, thirteen troops of Artillery Drivers, and two foreign battalions.

The Non-Effective force, consisting of Invalids and Master-Gunners, are usually in charge of towers and batteries; the latter being Store Accountants, and the situation affords a handsome retirement to the deserving Non-Commissioned Officers of the Royal Artillery.

The *Distribution* of the Personnel into Horse Artillery, destined to move with Cavalry; Foot Artillery, attached to field batteries, generally acting with Infantry; and the Artillery for garrison and Colonial duties, is arbitrary; and the whole is still one regiment, the men and Officers being applicable, in the course of service, to all these duties at the pleasure of the Master-General, as circumstances may direct.

2. The Equipment of Artillery for the field, for coast defences, sieges, and the armament and defence of places, is a combination of the elements of men, matériel, and horses, necessary for those services; and is *organized* by the Department of the Director-General of Artillery. Under his control, these Equipments for the Field are for

Horse Artillery.
Rocket Artillery.
Field Foot Artillery.
Mountain Artillery.
Artillery of Reserve or Position.

And the Equipments of Heavy Artillery are for

Siege Artillery.
Artillery for Coast Defences.
Artillery for the Armament of Places.

3. Artillery Stores, and materials for conversion, are generally obtained by contract, and placed in charge of the Storekeeper-General's Department for dis-

tribution or for conversion, as explained in the following paragraph, or in the Equipments named above.

4. The construction and fabrication of Artillery from the materials into the component parts of ammunition, ordnance, and carriages, are executed in the Royal Arsenal, Woolwich; and the proof of those articles, when furnished by private individuals or companies, forms an important branch of the Artillery service.

5 and 6. The Elements of Instruction referred to in the preceding Synopsis are fully adequate, theoretically and practically, to render the men and Officers excellent Artillerists.

In concluding the description of the administration and organization of the Royal Artillery, it should be explained that this arm of Her Majesty's forces, after leaving the establishment at Woolwich, is under the command of the General Commander-in-Chief of Her Majesty's Land Forces, and obeys all Commanders of forts, districts, garrisons, and colonies, with all troops of Her Majesty's Army, subject to certain responsibilities of economy, detail and expenditure of money and stores, to the Master-General and Board of Ordnance.

SECTION III.

The application and proportion of Artillery to

Field and Positions . .
Sieges . . . .
Armament of Places, and
Coast Defences . . .

} See 'Composition of Batteries,' Table I.; and 'Equipment.'

As there is no regulated or fixed principle in the application of Artillery to the several services before mentioned, and as the question interests every branch of the British Army, the following data are given as the probable basis for the armament of batteries.

SECTION IV.

Artillery, applicable to the field, consists of

Horse Artillery Batteries.
Field Foot " "
Mountain " "
Rocket " "
and Artillery of Reserve or Position.

1. The batteries of *Horse Artillery* are usually composed of 6-pounder brass guns, and 12-pounder howitzers in batteries of six pieces, as best adapted to move with Cavalry. See Tables F. I.

2. The armament of the *Field Foot Artillery* attached to the Infantry Corps when the roads are tolerably practicable, are now formed of 9-pounder brass guns and 24-pounder brass howitzers. See Tables F. I. But as the difficulties of moving Artillery increase, so must the calibre of the ordnance be reduced. The field batteries in the early part of the Peninsular War consisted of 3 and 6-pounder brass guns, and of $5\frac{1}{2}''$ and $4\frac{2}{5}''$ howitzers: at the conclusion, 9-pounder guns were used.

3. The *Mountain Artillery* is usually limited to 3-pounder brass guns, and $4\frac{2}{5}''$ howitzers, conveyed on the backs of mules: the difficulty of transport renders it convenient to compose these batteries of three guns and one howitzer, as the ordnance carriage and ammunition have to be fixed on pack-saddles. See Tables F. and I.; 'Carriage,' Pl. XXIX.; and 'Equipment.'

If the animals for the conveyance of Mountain Artillery are not well accustomed to carry weights on their backs, and used to mountain roads, the application of this

branch of Field Artillery is almost impracticable; and the battery, at best, is ineffective.

Rocket Artillery for the Field seems more applicable to countries without roads than Mountain Artillery; and also, where they are much intersected by rivers, and in marshy or boggy districts; as well as for Advance Guards. Hitherto, their practical effect has not been satisfactory. See Table J.

Artillery of Position or *Reserve* may be composed of 9 and 12-pounder brass guns, and 32-pounder brass howitzers; or the 18-pounder iron gun, with an 8-inch iron howitzer: if of brass, the batteries consist of six pieces; if of iron, only four. This description of heavy Field Artillery, in *offensive* operations, becomes 'Artillery of Reserve,' to be brought forward in critical periods of attack, or to insure success when the adverse forces begin to waver; and it is peculiarly adapted to the attack of posts and villages. In *defensive* operations it may be termed 'Artillery of Position,' for the occupation of the prominent features in the field of battle, and commanding ground securing the position by its superior fire. See Tables E. F. I.

The proportion of Field Artillery to an army is generally regulated by the description of the country in which the army is to act, and the means of transport; but these should rather decide the *nature* of the ordnance to be employed than the *quantity*, considering the vast resources of Great Britain. With the Anglo-Portuguese army in the Peninsula, the proportion of Artillery was one to every thousand; and with the army of occupation in France, it was three to every thousand men. Napoleon preferred two to every thousand, with a large proportion of ammunition; and this rule seems to be admitted in modern armies.

And the proportion of two pieces of ordnance for every thousand Infantry may be found better suited to our service, considering how much the perfection of the Infantry force diminishes the quantity of Artillery necessary for an army.

Therefore, taking an army destined for the field as 60,000—of which 50,000 is Infantry—7500 Cavalry, and about 2500 Artillery, the maximum number of pieces of Artillery will be 100 in the proportion of

5 batteries of Horse Artillery, or 30 pieces for 5 brigades of Cavalry.
9 batteries of Field Artillery, or 54 pieces for 8 divisions of Infantry.
3 batteries of Reserve or Position, 16 pieces for the whole force.

Whether four, six, or eight pieces shall be the strength of the batteries, is generally a professional or Artillery question; but its consisting of six does not appear to be imperatively necessary.

It would seem desirable to establish as a principle, that the Field Foot Artillery attached to Infantry should not possess the mobility of Horse Artillery; and that the latter should not have the power of the former, by being armed with pieces of heavy calibre, as the efficiency of Horse Artillery depends upon the facility of moving and supporting Cavalry.

SECTION V.

HEAVY ARTILLERY.

1. *Application of Artillery to Sieges.*—In the consideration of this subject also, the same two important points have to be decided—the nature of the ordnance to be employed, and the quantity. Adverting to the several sieges during the last wars, and the suggestions offered on the experience obtained from those events, the following inference is drawn as to the nature of Artillery necessary for a siege operation.

NATURE OF ORDNANCE.

That the 24-pounder iron 9 feet 6 inch gun should be generally, if not invariably, used for direct fire and breaching.

That the 8-inch iron howitzer, with the 24-pounder iron gun, is most suitable for enfilade fire, as well as for the demolition of parapets and exposed scarps when placed in the first parallel.

And that the 10-inch iron mortar be adopted for vertical fire, whether used for bombardment and the destruction of the magazines and platforms, or ultimately as pierriers, this latter piece not being known in our service.

These, with a proportion of small mortars, will be found, as regards the nature of the Artillery necessary, more effectually to produce early and successful results. Although the 12 and 18-pounders iron guns are still among the enumerated descriptions of ordnance for the attack of places (see Table E.), experience does not justify their use, except in cases where none other can be obtained; and as Sir John Jones, in his 'Journals of Sieges,' observes, "It is neither vertical, ricochet, nor direct fire alone, but a judicious combination of the three which will prove irresistible;" and hence the

24-pounder gun for direct fire,
8-inch howitzer for ricochet, and
10-inch mortar for vertical,

are proposed for a battering train of heavy artillery to accomplish these objects.

QUANTITY OF ORDNANCE.

The quantity of ordnance necessary is equally important in the attack of places. There is a considerable difference in the authorities hitherto given of the number of pieces of Artillery required, and the experience obtained in the reduction of fortresses rather shews that the quantity used was guided by expediency and the accidental resources of the moment.

The following proportion has been adopted (by a Committee of Artillery Officers in 1819, *vide* 'Equipment,') as a siege equipment or battering train, and 100 pieces of heavy ordnance is given as the basis for all future siege operations.

Iron	24-pounder guns	40 pieces.	100.
	12 " "	20 "	
	Howitzers	15 "	
	Mortars	25 "	
Brass	5½ mortars	20 "	40.
	4⅖ "	20 "	

But independent of the objection to the use of 12-pounder guns, which did not meet the sanction of the Duke of Wellington, proposed for enfilade fire, and the small number of howitzers, the quantity recommended does not seem a convenient number to divide for inferior attacks; and it is questionable if the number is adequate as a maximum proportion.

It is suggested therefore to establish a minimum quantity for the smallest siege operation.

Major-General Sir J. Burgoyne, in the article 'Attack,' considers 25 pieces of heavy ordnance as the minimum battering train to belong to an army for the reduction of forts.

Without adopting this for a minimum force, it is proposed to consider 30 pieces of heavy ordnance, with a proportion of brass mortars, as a small battering train for an Artillery siege equipment, in the proportion of

Iron	24-pounder guns	15, or $\frac{3}{6}$	30.
	8-in. howitzers	10, or $\frac{2}{6}$	
	10 mortars	5, or $\frac{1}{6}$	
	+		+
Brass	6⅖ mortars	5, or $\frac{1}{6}$	10.
	5½ "	5, or $\frac{1}{6}$	

See 'Construction' of Artillery, Sect. VI.

This minimum siege equipment it will be found more convenient to double, triple, or quadruple, than to divide the larger proportion of 100 pieces of heavy ordnance for the attack of fortresses of second and third, or fourth orders.

Sir J. Jones proposes for a siege equipment,

Iron . .	24-pounders	40	106 pieces of heavy artillery.
	18-pounders or heavy howitzers .	20	
	Mortars	46	

The 'Aide-Mémoire à l'usage des Officiers d'Artillerie,' (edition of 1844,) gives the following as a siege equipment:

Brass .	24-pounder guns	40	162 guns of heavy artillery.
	16 " "	40	
	8-in. howitzers (22cs.)	40	
	10-in. mortars (27cs.)	15	
	8-in. " (22cs.)	15	
	Pierriers	12	

And in the same work the following examples are detailed of different siege equipments:

As proposed by	Pieces of Ordnance.	In the proportion of, per 100, Guns.	Howitzers.	Mortars.	Pierriers.
Vauban	160	70	—	15	15
Bousmard	168	50	18	22	10
Durtubie	207	62	12	18	8
Dupuget	200	65	12	18	5
Gassendi	160	62	15	15	8
Austrian Equipment .	178	45	13	35	7
Prussian " .	142	60	15	20	5

It appears likewise in Jones's 'Sieges,' that the under-mentioned pieces of artillery were in battery at the attacks of the following places by the British Army, upon

	Guns, Iron.		Howitz., Iron.		Carron.	Mortars, Iron.		Field Ordnance.
	24-prs.	18-prs.	$5\frac{1}{2}$-in.	8-in.	8-in.	10-in.	13-in.	Brass pieces.
Ciudad Rodrigo	23	4	—	—	—	—	—	2
Third siege of Badajos . .	16	20	16	—	—	—	—	4
St. Sebastian .	30	6	—	7	4	15	1	—

And in the 'Aide-Mémoire d'Artillerie,' the following were in battery in the French sieges in Spain:

	Number of Pieces of Ordnance.	In the proportion of, per 100, Guns.	Howitzers.	Mortars.	Pierriers.
Mequinenza . in 1810	18	55	45		—
Ciudad Rodrigo " 1810	50	58	16	22	4
Almeida . . " 1810	67	62	18	13	7
Tortosa . . . " 1810	50	40	60	—	—
Lerida . . . " 1810	40	6	15	15	—
Tarragona . . " 1811	66	—	—	—	—
Badajos . . . " 1811	54	62	23	15	—

These examples are to be taken only as matters of fact, of what has been effected under the then existing circumstances, and the resources of the French and British Armies, both distant from their several dépôts; but it is the discrepancy of the several propositions given in the authorities before quoted which suggests the proportion herein advocated, of having, as before stated,

24-pounder guns $\frac{3}{6}$ths.
8-inch howitzers $\frac{2}{6}$ths.
10-inch mortars $\frac{1}{6}$th.

And which, however, corresponds nearly with the latest siege equipages recommended by the French Officers in 1844, more particularly in the introduction of the large proportion of 8-inch howitzers; and Sir John Jones, in his 'Journals of Sieges,' Note 29, observes, "since the recent improvements, ~~in~~ the 8-inch and 10-inch howitzers will naturally, in future sieges, be made to supplant most of the guns hitherto used for enfilading."

The arrangement combines the advantages of effect and simplicity, as likewise of economy in the application of three descriptions only of heavy ordnance to the attack of places, and affords, by adopting a minimum quantity (30) for siege equipments, much convenience in transport, when embarked for any operations of an Army not specifically arranged beforehand, but assumed on the probable wants of a campaign.

The scheme of adopting small siege equipments instead of the maximum of the several propositions of

100 of the Committee of Royal Artillery,
100 of Sir John May, Royal Artillery,
106 of Sir John Jones, Royal Engineers,
162 of French Artillery Officers,
or 200 of several authors,

is left for consideration; but the disuse of 12 and 18-pounder guns is a simple question of calculation, the effects of these, as to time, being in the experiments at Metz, in 1834, the inverse ratio of the weight of shot; and the effect calculated for the destruction of the parapets and traverses may be considered in the inverse ratio of the cubes of the diameter of the shot or shell of the

$$\left.\begin{array}{l}\text{8-inch howitzer}\\ \text{24-pounder gun}\\ \text{18 ,,}\\ \text{and 12 ,,}\end{array}\right\}\text{Iron.}$$

And whether it is a question of time, effect, or economy of transport, this proposition for Artillery for sieges, consisting of

Maximum Equipment.				Minimum Equipment.
120	60 — 24-pounder guns	. . or, 4 × 15	30	
	40 — 8-in. howitzers	. . ,, 4 × 10		
	20 — 10-in. mortars	. . ,, 4 × 5		
	120 and			
+	40 — Small brass mortars	. ,, 4 × 10	+ 10	
= 160			= 40	

is suggested as embracing either part or the whole of these advantages.

It is assumed that a corresponding Engineer Equipment will accompany it, and not with the expectation of reducing a place with Artillery alone.

In the 'Application of Artillery to the Field,' there is a proposition for reducing small posts by means of Artillery of Reserve; and this, and what other proportion of

Field Artillery may be attached to the besieging army, will serve to arm the works constructed to protect the flanks of the parallels, and for use against sorties.

2. *Coast Defences.*—The arrangement best suited for the armament of maritime places and batteries, for the protection of harbours, roadsteads, rivers, and coasts, is the combination of the 56-pr., 32-pr. long iron gun, 13-inch iron mortar, and 8-inch iron howitzers, for all positions; and none under these calibres should, it is conceived, be mounted in coast defences, to contend with the present armament of ships of war. Since the introduction of the large calibres, the use of this heavy ordnance has become indispensable for coast batteries; but the application of those pieces seems limited to peculiar instances, in consequence of their immense weight, and the impracticability of using them when mounted on traversing platforms firing over a parapet 7 feet high. The 56-pounder, or Monk's gun, of 11 feet in length, and 97 cwt., is preferred for Land Service, for which a traversing platform is provided, since this gun has been introduced; and the range and accuracy of its fire renders it superior to the 68-pounder, or to the 80-pounder Paixhans' guns; the 68-pounder having the advantage, however, at present, of throwing 8-inch shells, and hollow as well as solid shot, though this last, only, can be used red-hot.

The 24-pounder gun, 9 feet 6 inches in length, is much esteemed by Artillerists, on account of the facility of working it, and its effectiveness against shipping: as there is a vast number in the Service, they will be necessarily placed in coast defences for some time.

It appears that the relative importance of Artillery for Coast Defences in these suggestions is—

The 32-pounder gun.
13-inch mortar.
8-inch howitzer, or gun.
56-pounder gun.
24-pounder gun.

The application is more fully explained in the article 'Defence' of Coasts.

3. *The Application of Artillery to the Defence of Places.*—There does not appear to be any rule in our Service for the armaments of forts and fortresses. In the French Service, by their latest regulations on this head, it is directed that the fortified places should consist of three classes, according to their relative importance; and the Artillery necessary is divided into two portions, the one being appropriated for the immediate security of the place, and the other which is necessary to sustain a siege: the former is always mounted in battery, and the latter placed in store.

The quantity necessary for the immediate security of the place is calculated at 10 per bastion, which provides for the armament of the salients and flank defences, as well as for the emplacement of the heavy mortars; but that requisite to sustain a siege must depend on the extent of the works generally, and is determined from the best and latest authorities: thus fortresses of the

			S	
First class,	consisting of 10 sides and upwards to the right line,	will require	110	pieces.
Second class,	„ 6 to 10 sides, of 180 toises front,	„	70	„
Third class,	„ 4 to 5 sides, of 150 toises front,	„	30	„

in addition to the 10 per bastion.

The French authors adopt the following mode of expressing the total number (x) of Artillery necessary for a fortress, on having the number of bastions (m) and the value of S, as given above:

$\overline{m \times 10} + S = x$. S representing the quantity for the front of attack; thus, supposing the octagon the work to be armed, the quantity required will be $\overline{8 \times 10} + 70 = 150$ pieces.

The proportion of Artillery is usually $\frac{5}{10}$ of heavy guns.
$\frac{1}{10}$ „ howitzers.
$\frac{3}{10}$ „ mortars.
$\frac{1}{10}$ „ field pieces.

The nature and disposition of these being regulated by the previous arrangement explained of providing for the immediate security, and the Artillery necessary to sustain a siege.

For the first it is suggested that the armament might advantageously in our Service consist of

32-pounder guns for the salient angles of the bastion, mounted on traversing platforms.
24 „ for the flank defences, on ground platforms.
10-inch howitzers in the salient angles of ravelins, en barbette.
13-inch mortars in the bastions, for vertical fire.

This Artillery for Immediate Defence will be used likewise during the early period of attack, the number necessary, as above stated, being ten per bastion.

That necessary to sustain a siege, in addition to the above, should consist, it is conceived, principally of 18-pounder long iron guns, on travelling carriages.
$6\frac{1}{5}$ howitzers (Dundas) ditto.
$6\frac{1}{5}$ mortars. See 'Construction,' Section VI.

These being in store previous to the investment.

As an example to explain the quantity and nature of Artillery necessary for an octagon under both emergencies, in the proportion of $\frac{5}{10}$, $\frac{1}{10}$, $\frac{3}{10}$, and $\frac{1}{10}$, the following is given.

Nature of Work.	Guns.			Howitzers.		Mortars.			Field pieces.	Total.
Octagon.	*a.* pr. 32	*c.* pr. 24	*f.* pr. 18	*b.* in. 10	*g.* in. $6\frac{1}{5}$	*d.* in. 13	*h.* in. 8	*i.* in. $6\frac{1}{5}$	*e.* Brass.	
For Immediate Security	8	32	—	8	—	24	—	—	8	80
To sustain a Siege . .	—	8	27	—	7	—	11	10	7	70
	8	40	27	8	7	24	11	10	15	150
	75			15		45			15	

Application of the Artillery to the defence.

a. To be mounted on salient angles of all bastions of Enceinte; those of the fronts attacked being brought, after the first period, to the curtains of collateral fronts.
b. To be mounted in salients of ravelins; those of the fronts attacked being removed to angles of the shoulder of the collateral bastions.
c. For the flank defences; those of the fronts attacked being reinforced at the second period of defence.
d. To be divided off to the several bastions.
e. In the outworks and for sorties.
f. For the second period of defence, and armament of the faces of the fronts of attack.
g. Ditto.
h. For the outworks at the second period of defence.
i. For the covert-way at ditto.

This arrangement is arbitrary, and suggested when a choice of Artillery is permitted: for those places already armed, it is not proposed to disturb the selection made.

In the event of the fortress having an interior elevated line of works, or cavaliers, commanding the surrounding country, the heavy 56-pounder gun would serve, particularly for the early period of defence.

In maritime places, the Artillery for the sea faces will be regulated by the rules providing for the armament of coast defences.

The selection of Artillery for the defence of fortresses is not based upon the principle which guided that proposed for the attack; the latter having in consideration the difficulty of transport, which in the former is of minor importance. Hence the 13-inch mortars, 10-inch howitzers, and 32-pounder guns, are proposed especially for the early period of defence; and the 24-pounder guns for the flank defence, as combining calibre with facility of working the pieces.

For the second period of defence, the 18-pounder guns and $6\frac{1}{5}$ howitzers are selected, their mobility being of some consequence at that period; and the shot or shell of those pieces being quite equal to penetrate the newly-formed parapets of the besiegers. The $6\frac{1}{5}$ mortars are proposed under the supposition that they will be brought into the Service.

SECTION VI.

CONSTRUCTION OF ARTILLERY.

Some remarks are now offered with the preceding observations on Artillery, and with reference to the Tables of dimensions, weights, and ranges of iron and brass ordnance for Land Service.

The Tables A. B. C. do not correspond precisely with what has been suggested as applicable in the preceding part of this Paper to the different services detailed for the field, for sieges, defences of coasts and harbours, and for the armament of places, as those propositions are founded upon the improvement of Artillery, which implies the abandonment of a large proportion formerly in use.

For example. At an early period, the short and small calibre iron guns were introduced for the convenience of the Navy; such as the 6, 9, and 12-pounder guns of various weights. For the same purpose the carronades were brought into the Service, from the 12 to the 68-pounder; they were generally adopted for Land and Sea uses; and, at the close of the war, a species of ordnance, combining the gun and carronade, was introduced by Sir Wm. Congreve for the armament of ships. These varieties are nearly all set aside in the British Navy, and it is armed generally with one calibre*—the 32-pounder, of different lengths and weights, adapted to the size of the vessel; thereby insuring an effective gun, as well as establishing uniformity, and preventing confusion in serving the ammunition. The larger vessels, from the frigates upwards, have a proportion (about $\frac{1}{10}$th) of the 68 gun, for firing shot, shells, or hollow shot.

As one department (that of Artillery) supplies all the Ordnance, whether for the Land or the Sea Services, these changes throw a great quantity into store; and they are used as the circumstances require.

Adverting to the construction of Artillery and the above-mentioned variety, it would seem desirable to establish for the *Land Service* one construction peculiarly suited by its calibre, so that the piece shall be most perfect of its kind, in respect to its range and weight; and the terms 'light,' 'medium,' and 'heavy' should be obsolete; this distinction being unknown to other Services, except those in which our system has been copied. In making a selection amongst pieces of different calibre, the decision will be much influenced by the weight of ammunition thereby entailed; but when the question lies amongst ordnance of the same calibre and of

* Vide 'Equipment,' Naval.

different weights, there can be no economy in, no plea for, dragging along a gun of imperfect and unsatisfactory character.

The following observations refer to construction; first, as regards the $6\frac{1}{5}$ howitzer, lately introduced by Colonel Dundas into the Service, of 10 calibres and 17 cwt. It would be desirable to have as a corresponding piece the $6\frac{1}{5}$ mortar of brass, and to consider the $4\frac{2}{5}$ mortar as too small and inefficient; the smallest in the French Artillery being 15 centimetres, or about 6 inches.

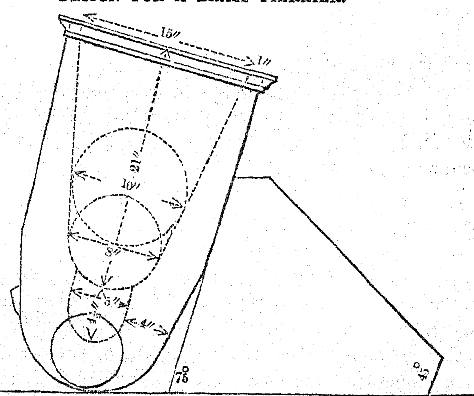
Secondly. Difficulties occur in siege batteries when the howitzer is used, in consequence of the muzzle not entering into the throat of the embrazure; the cheeks are then blown away, and the men exposed after a few rounds are fired. Two expedients might be adopted to remedy this inconvenience; either to provide for mounting the 8-inch howitzer on garrison carriages; or, to lengthen the piece to eight calibres corresponding with the 68-pounder carronade; but this last plan would involve difficulties in building a travelling carriage of sufficient strength.

Thirdly. If the 10-inch mortar is considered sufficient for siege operations, and the maximum calibre for the mortar in the French Service is 27 centimetres (about 10·63 inches), the construction of a 13-inch Land Service mortar of range equal to that of the 56-pounder gun—3500 yards—may be worthy of consideration for coast defences, and the armament of places, as the question of transport is not of importance in such cases.

Lastly. The use of the pierriers, or stone mortars, seems indispensable if sieges are to be conducted beyond the third parallel. It has been conceived that they might be made of a light construction, so as to throw a large shell, as well as stones, from 50 to 60 yards: probably if the bore were cast in the form of a truncated cone, the muzzle being 15 inches, and the length of the bore 26 inches, including the chamber, and the thickness of the metal not to exceed 1 inch in the smallest part of the muzzle, not reckoning the mouldings, the weight would not exceed 10 cwt.

The subjoined is arranged for throwing a bushel of stones 50 to 60 yards, or 10-inch and 8-inch shell about 100 yards. The bushel baskets, required so much in the Engineer Department, if made to correspond with such form and dimensions, would pack with ease into each other, and, when nearly worn out, be serviceable for these pierriers.

DESIGN FOR A BRASS PIERRIER.



Weight about 8 cwt.

Holds about $1\frac{1}{4}$ cub. ft. of stones; presumed range, 50—60 yards.

Also the 8″ or 10″ shell, for short ranges.

If of iron, to like effect, would weigh 17—18 cwt.

Entire length .	$29\frac{1}{2}$ inches.
Length of chase .	21 ,,
Do. chamber .	$4\frac{1}{2}$,,
Thickness of metal at do.	4 ,,
Do. at muzzle .	1 ,,

Diameter of bore at muzzle 15″. Bottom 8″. Chamber 5″.

The following pieces of Artillery are proposed as sufficient to meet all the wants of the Land Service, notwithstanding the numbers yet retained in the Service, as a matter probably of convenience and economy, as given in Tables A. B. C.

Guns	*a.*	68-pounder gun		Iron.
	a. b.	56 „ „		
	a. b.	32 „ „		
	b. c.	24 „ „		
	b. c.	18 „ „		
	e.	12 „ „		Brass.
	d.	9 „ „		
	d.	6 „ „		
	f.	3 „ „		
Howitzers	*b.*	10 inch.		Iron.
	a. c.	8 „		
	b. c.	$6\frac{1}{5}$ „		Brass.
	d.	$5\frac{1}{2}$ „	and 24-pounder.	
	d. f.	$4\frac{2}{5}$ „	and 12 „	
Mortars	*a. b.*	13 „		Iron.
	b. c.	10 „		
	b.	8 „		
	b. c.	$6\frac{1}{5}$ „		Brass.
	c.	$5\frac{1}{2}$ „		

Application:
- *a.* Sea defences.
- *b.* The armament of places.
- *c.* Sieges.
- *d.* Field Artillery,
- *e.* Ditto of reserve.
- *f.* Ditto for mountains.

It will be perceived, that in the British Service all the light (or field) Artillery is at present constructed of brass, and that all the heavy is of iron.

For the Theory of Construction, see 'Gunnery,' and some valuable observations in Jones's 'Sieges,' (Note 17, vol. i. second edition.) G. G. L.

ARTILLERY TABLES.

A. B. Dimensions and Weights of Iron Ordnance.
C. Ditto Brass ditto.
D. Calibres of Ordnance. Diameters of Shot and Shell.
E. Charges, Ranges, and Application of Iron Land Service Ordnance.
F. Ditto, ditto, of Brass Ordnance.
G. Depressions of Garrison Artillery to the present date, January, 1845.
H. Depressions and Elevations as proposed in future.
I. Composition of Field Batteries.
J. Rockets.

REMARKS AND NOTES.

TABLES A. B. C.—Very few systematic constructions of Ordnance being extant, and the varieties amongst those for guns of the same calibre being notorious, the Committee has adopted the plan of giving one General Table of Dimensions for all Ordnance now in the Service, taking care, as much as possible, to represent like parts in all by the same letters.

For the execution of the very laborious task of filling in these Tables from actual admeasurement, we are indebted to the zeal and kindness of Captain Gore, Royal Artillery.

Note A, Table A. With reference to the forms of 'Bored-up' guns, which at present hold an intermediate place between the 'Ordinary' and 'Millar' constructions, the practice is variable, as the operation itself was experimental. Generally speaking, guns of 'ordinary' proportions were placed in the lathe, and modified somewhat to Millar's shapes, by the second reinforce being sloped to nearly a continuation of the chase, and by the moulding beads being turned off to flat fillets. In some instances, metal has been taken off inside and outside, whilst in others the bore only has been increased, and that even by two calibres.

Note B, Table B. In Carronades, the 'length of the bore' does not include the cup at the muzzle.

Note C, Table B. In mortars, the bore is divided into two parts—chase and chamber; the chase extends from the face of the piece to the seat of the bottom of the shell; the chamber comprises the remainder of the conic frustrum occupied by the charge; but in the Tables, 'length of bore' is given as from the face of the mortar to the bottom of the chamber.

D.—This Table was specially applied for as an authority, in consequence of the variation of calibres of the same denomination; thus, there are no less than five different calibres for the 32-pounder, as now in the Service.—*Vide* Griffiths. Ed. 2, p. 61.

E.—This has been recently circulated as an order by the Master-General and Board. Two columns, for calibre, and point blank, have been added for this work.

F.—Compiled from the best authorities, as far as materials could be obtained.

J.—This gives all that is considered necessary for general purposes.

Service.	Construction.		Length.		Weight.	AB.	AC.	AD.	AE.	AF.	AG.	AG′.	AH.	AI.	AJ.	A.	C.
						LENGTHS.											
*	*		″	′	cwt.	″	″	″	″	″	″	″	″	″	″	″	″
S.	M.	10-in. gun (hol. shot or shl.)	9	4	84	15·6	5·5	23·85	44·8	56·0	67·0	,,	99·3	109·2	112·0	26·0	25·0
S.	M.	~~8 do.~~ 68-pr. (Dundas) do.	10	10	113	16·87	5·1	27·75	52·	58·5	65·0	,,	115·7	127·15	130·0	29·2	27·56
S.L.	M.	8 do. do.	9	0	65	14·7	5·16	23·04	43·2	54·0	60·5	,,	95·95	105·82	108·0	23·5	22·3
L.	M.	8 do. do.	6	8½	50	16·5	5·5	23·5	34·0	40·5	44·0	,,	69·0	78·0	80·5	24·0	22·5
L.	M′.	56-pr. gun (Monk)	11	0	97	15·04	4·9	28·15	49·5	59·4	62·48	,,	117·48	129·11	132·0	28·0	26·35
S.	M.	42 do. (Dundas)	9	6½	85	14·5	2·4	25·6	37·55	54·0	60·0	,,	100·6	112·0	114·6	26·5	24·75
S.L.	O.	32 do.	9	6	56	11·2	2·75	11·25	32·6	48·9	51·31	,,	102·24	111·49	114·02	20·34	22·24
S.	M′.	32 do. (Monk's A.)	9	0	50	12·13	4·3	23·07	41·85	48·6	51·84	,,	96·12	105·54	108·0	22·46	[illegible]
S.	M′.	32 do. (Monk's B.)	8	6	45	11·9	4·1	21·77	39·53	45·9	49·0	,,	90·78	99·78	102·0	21·97	20·4
S.	M′.	32 do. (Monk's C.)	8	0	42	11·9	3·88	20·49	37·2	43·2	46·05	,,	85·49	93·8	96·0	21·9	20·3
S.L.	I.	32 do. (a bored-up 24)	6	6	33	9·43	1·42	9·08	22·28	33·42	38·33	40·9	70·24	76·45	78·0	19·76	19·9
S.	I.	32 do. (a bored-up 18)	6	0	25	10·5	2·5	,,	20·75	30·5	35·0	36·5	64·0	70·5	72·0	17·5	18·0
L.	O.	24 do.	9	6	50	10·43	2·72	10·6	32·6	48·9	54·72	,,	102·16	111·61	114·0	19·28	20·9
L.	O.	24 do.	9	0	48	10·33	2·7	10·6	30·85	45·85	52·2	,,	97·2	106·0	108·0	19·1	20·9
L.	I.	24 do. (a bored-up 12)	6	0	20	8·21	2·15	7·52	20·57	30·85	35·47	36·0	64·7	70·52	72·0	16·95	17·6
S.	M′.	56 do. (Monk)															

ARTILLERY TABLE B. CONSTRUCTION OF

Service.	Construction.		Length.		Weight.	AB.	AC.	AD.	AE.	AF.	AG.	AG′.	AH.	AI.	AJ.	A.	C.
						LENGTHS.											
*	*		′	″	cwt.	″	″	″	″	″	″	″	″	″	″	″	″
L.	O.	18-pr. gun	9	0	42	9·52	1·92	9·82	30·86	46·29	51·58	,,	96·7	105·7	108·0	18·06	19·68
L.	I.	18 do. (a bored-up 12)	6	0	20½	8·21	2·15	7·52	20·57	30·85	34·31	36·04	64·7	70·52	72·0	15·92	16·2
L.	O.	12 do.	9	0	34	8·5	1·93	9·1	30·86	46·29	50·91	,,	96·58	105·54	108·0	16·32	17·73
L.	O.	6 do.	6	0	17	6·75	1·42	7·0	20·57	30·8	34·7	,,	64·25	70·6	72·0	15·0	15·06
S.	O.	32-pr. carronade.	3	11¾	17	15·6	2·9	15·9	20·2	21·34	41·68	,,	42·03	43·55	47·71	17·46	[illegible]
S.	O.	24 do.	3	7⅖	13	14·38	2·63	14·47	18·4	19·42	37·75	,,	38·08	39·72	43·4	15·68	[illegible]
S.	O.	18 do.	3	9¼	10	13·05	2·4	13·05	16·58	17·5	34·09	,,	34·62	35·62	39·25	14·33	13·63
S.	O.	12 do.	2	8⅓	6¾	11·19	2·24	11·44	14·62	15·49	27·68	,,	27·98	29·34	32·36	12·6	11·98
L.	M.	10-in. howitzer	5	0	41	11·86	3·0	17·68	25·86	30·0	36·0	,,	51·1	58·2	60·0	23·24	22·5
L.	M.	8 do.	4	0	21	9·4	3·7	14·24	20·8	24·0	29·0	,,	41·0	46·4	48·0	18·6	18·0
L.	O.	5½ do.	3	4¾	15	7·84	2·55	,,	17·46	20·38	21·48	,,	37·9	39·5	40·76	17·5	16·2
S.	O.	13-in. mortar.	4	4	100	11·5	23·62	26·01	39·01	,,	,,	,,	48·73	,,	52·01	(B.) 31·7	34·95
L.	O.	13 do.	3	3½	36	7·9	14·95	16·9	18·9	,,	,,	,,	35·6	37·6	39·6	(B.) 21·12	25·35
S.	O.	10 do.	3	9	50	11·3	18·32	20·0	31·25	,,	,,	,,	42·5	,,	45·0	(B.) 25·4	26·0[illegible]
L.	O.	10 do.	2	7½	18	7·25	11·69	13·69	15·69	,,	,,	,,	27·53	29·53	31·53	(B.) 18·75	
L.	O.	8 do.	2	1¼	9	5·85	9·37	10·97	11·65	,,	,,	,,	[illegible]	[illegible]	[illegible]	(B.) [illegible]	

DIAMETERS.†								Trunnions.			Thickness of Metal.		Calibre.	Length of bore.	Chamber.			Note.
D.	E.	F.	G.	G′.	H.	I.	J.	Diam.	Length.	Span.	At Breech.	At Muzzle.			Length.	Diameters.		
″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	
24·9	,,	22·5	20·45	,,	16·4	20·22	14·6	7·25	6·0	36·5	7·5	2·3	10·0	109·33	11·83	10·0	7·3	
26·35	,,	23·5	21·3	,,	16·13	19·22	14·6	8·12	6·5	38·0	9·82	3·27	8·12	123·4		Nil.		
22·2	,,	19·8	17·95	,,	14·08	16·0	12·8	7·25	6·0	33·3	7·1	2·38	8·05	105·27	13·44	8·05	5·8	
21·5	,,	20·0	18·5	,,	15·0	18·75	13·0	6·0	6·0	33·5	7·0	2·33	8·05	80·5	13·38	8·05	5·95	
25·03	,,	21·1	19·6	,,	13·92	17·8	12·4	7·67	6·5	36·5	8·32	2·34	7·65	124·87		Nil.		
23·4	,,	22·35	20·9	,,	14·37	18·2	13·2	6·97	6·0	34·3	9·76	3·11	6·97	114·0		Do.		
19·86	18·8	17·72	17·38	,,	13·3	16·45	12·48	6·41	6·61	30·9	6·9	2·98	6·41	107·2		Do.		
[illegible]	,,	16·82	15·72	,,	11·26	14·14	10·04	6·35	5·75	29·87	7·9	1·84	6·35	103·08		Do.		
19·35	,,	16·48	15·41	,,	11·1	14·12	9·92	6·35	5·75	29·87	7·67	1·78	6·35	97·23		Do.		
19·35	,,	16·45	15·3	,,	11·1	13·72	9·9	6·35	5·75	29·42	7·63	1·77	6·35	91·25		Do.		
18·14	17·75	16·48	15·98	14·98	12·04	13·99	10·22	5·82	5·9	26·28	5·65	2·5	6·3	71·79		Do.		A.
,,	16·4	15·6	15·1	14·29	11·2	13·1	11·0	5·3	5·0	25·6	5·85	2·35	6·3	67·7		Do.		
18·76	18·02	16·88	16·46	,,	12·36	15·17	11·08	5·82	6·0	28·75	6·7	2·63	5·82	107·41		Do.		
18·7	18·0	16·8	15·8	,,	12·3	15·16	11·0	5·82	6·0	28·75	6·44	2·59	5·82	101·3		Do.		
15·46	14·95	14·5	13·3	12·85	10·4	13·27	10·1	4·62	4·62	23·4	5·28	2·75	5·75	66·37		Do.		

DIAMETERS.†								Trunnions.			Thickness of Metal.		Calibre.	Length of bore.	Chamber.			Note.
D.	E.	F.	G.	G′.	H.	I.	J.	Diam.	Length.	Span.	At Breech.	At Muzzle.			Length.	Diameters.		
″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	
17·82	16·9	15·8	15·4	,,	11·56	14·25	10·8	5·29	5·42	26·75	6·32	2·75	5·29	101·75		Nil.		
14·92	14·9	14·15	13·3	12·82	9·31	13·23	8·3	4·62	4·62	23·5	5·2	1·86	5·17	65·95		Do.		
16·2	15·2	14·28	13·94	,,	10·39	12·26	9·65	4·62	4·72	23·75	5·82	2·52	4·62	102·23		Do.		
14·6	13·0	12·15	11·85	,,	8·7	11·45	8·8	3·7	3·85	19·8	5·08	2·54	3·66	66·97		Do.		
[illegible]	,,	14·4	12·59	,,	11·86	10·78	8·92	* 2·72	,,	† 8·0	5·23	2·78	6·25	42·6	5·08	5·63	5·63	
13·84	,,	13·0	11·5	,,	10·78	10·21	8·11	2·46	,,	7·25	4·85	2·6	5·58	38·76	4·58	5·04	5·04	
12·89	,,	12·07	10·5	,,	9·74	9·22	7·3	2·24	,,	6·62	4·27	2·35	5·16	36·34	4·2	4·47	4·47	B.
11·16	,,	10·43	9·27	,,	8·6	7·86	6·45	2·0	,,	5·78	3·78	2·05	4·52	28·71	3·65	4·06	4·06	
22·4	,,	21·5	19·68	,,	17·52	20·06	16·14	7·0	6·0	34·74	6·62	3·1	10·0	58·46	11·25	10·0	7·5	
17·94	,,	17·25	15·76	,,	14·06	16·4	13·0	5·25	5·0	28·14	5·0	2·5	8·0	46·75	9·5	8·0	6·0	
,,	14·9	14·74	14·0	,,	11·9	13·16	12·07	5·1	5·1	25·75	5·4	2·95	5·68	32·75	5·1	3·64	3·64	
35·75	35·75	,,	,,	,,	{ 34·52 34·92	,,	34·52	11·37	8·53	52·81	,,	10·76	13·0	39·0	15·1	9·7	7·31	C.
25·35	24·65	,,	,,	,,	24·65	25·35	25·35	9·75	7·32	39·75	,,	5·83	13·0	32·5	11·6	12·5	6·5	
27·5	27·5	,,	,,	,,	{ 26·5 26·97	,,	26·78	8·75	6·56	40·62	,,	8·08	10·0	35·0	11·7	7·5	5·6	
	19·5	,,	,,	,,	19·5	20·0	20·0	7·5	5·0	30·0	,,	4·75	10·0	25·0	9·58	9·76	5·8	

ARTILLERY TABLE C.

CONSTRUCTIC

Service.*	Construction.*		Length. ′	Length. ″	Weight. cwt.	LENGTHS. AB. ″	AC. ″	AD. ″	AE. ″	AF. ″	AG. ″	AG′.	AH. ″	AI. ″	AJ. ″	A. ″	C. ″
L.	O.	12-pr. gun (medium)	6	6	18	6·71	1·2	7·2	21·83	34·93	39·53	,,	70·82	77·08	78·0	13·82	13·82
L.	O.	9 do.	6	0	$13\frac{1}{2}$	5·78	1·1	6·11	19·85	31·76	35·96	,,	64·31	70·21	72·0	12·6	12·6
S.L.	O.	6 do. (long)	7	0	12	5·84	1·2	5·08	27·1	37·33	40·47	,,	75·43	82·74	84·0	11·55	11·55
L.	O.	6 do. (light)	5	0	6	5·03	1·0	5·47	16·66	26·66	30·33	,,	54·07	59·11	60·0	9·62	9·62
L.	O.	3 do. (long)	6	$0\frac{4}{5}$	6	4·7	1·1	4·4	9·8	32·1	35·0	,,	65·2	71·6	72·8	8·7	8·7
L.	O.	3 do. (light)	4	0	3	4·1	1·1	4·4	13·33	21·32	24·32	,,	43·14	47·24	48·0	7·64	7·64
L.	O.	3 do. (colonial)	4	0	3	3·8	1·5	4·3	13·3	21·6	24·2	,,	43·0	47·2	48·0	7·6	7·6
L.	O.	3 do. (mountain)	3	0	$2\frac{1}{4}$	3·9	0·64	3·75	10·0	16·0	18·91	,,	32·57	35·25	36·0	7·65	[illegible]
L.	O.	1 do. (do.)	5	0	$2\frac{1}{2}$	3·56	1:0	3·6	16·67	26·7	28·72	,,	53·73	59·25	60·0	6·27	6·27
L.	M.	32-pr. howitzer (Dundas)	5	3	$17\frac{1}{2}$	7·26	3·45	17·85	27·3	31·5	34·78	,,	57·56	61·67	63·0	14·25	13·6
S.L.	M.	24 do.	4	$8\frac{1}{2}$	12	6·5	2·59	16·0	24·68	28·3	31·3	,,	50·1	55·48	56·5	12·8	12·2
L.	M.	12 do.	3	9	$6\frac{1}{2}$	5·3	2·62	12·95	19·8	22·34	25·1	,,	40·1	44·2	45·0	10·2	9·66
L.	O.	$4\frac{2}{5}$ inch (light)	1	$10\frac{3}{5}$	$2\frac{1}{2}$	3·67	1·69	6·49	7·31	11·28	14·08	,,	20·9	21·9	22·6	8·47	7·34
L.	O.	$4\frac{2}{5}$ inch (Coehorn)	1	$10\frac{3}{5}$	$2\frac{2}{3}$	3·52	1·68	6·3	7·2	11·27	14·15	,,	20·85	21·85	22·6	8·47	7·34
L.	O.	$5\frac{1}{2}$ inch mortar (Royal)	1	$2\frac{3}{5}$	$1\frac{3}{4}$	2·57	4·55	5·2	10·1	10·8	13·0	,,	13·7	13·8	14·35	(B.) 6·8	7·8
L.	O.	$4\frac{2}{5}$ do. (Cochorn)	1	$0\frac{2}{5}$	1	2·1	3·95	4·48	8·4	9·0	11·3	,,	11·8	11·9	12·43	(B.) 5·87	6·85

* S. *Sea Service.*—L. *Land Service.*—S.L. *Both.*—M. *Millar.*—M′. *Monk.*

† The breech and muzzle mouldings only are included in 'Diameters;' those at other points, and th

ARTILLER

Return shewing the Calibre of British Ordnance, and the Maximum and Minimum Diamete

		Nature of Ordnance.	ft.	in.	Calibre. inches.	Diam. of guages. Maxim. inches.	Minim. inches.	Mean diam. of shot. inches.
1	IRON.	~~68-pr gun~~ 8-inch guns.	9	0	8·05	7·95	7·9	7·925
2		~~68 do.~~	6	$8\frac{1}{2}$				
3		56 do.	11	0	7·65	7·51	7·45	7·48
4		32 do.	9	6	6·41	6·207	6·147	6·177
5		Do. do.	6	6	6·3			
6		24 do.	9	6	5·823	5·639	5·584	5·6115
7		Do. do.	9	0	do.	do.	do.	do.
8		Do. do.	6	0	5·75	do.	do.	do.
9		18 do.	9	0	5·292	5·124	5·074	5·099
10		Do. do.	6	0	5·17	do.	do.	do.
11		12 do.	9	0	4·623	4·476	4·432	4·454
12		6 do.	6	0	3·668	3·568	3·532	3·55
13		10-inch howitzer			10·0	9·88	9·8	9·84
14		8 do. do.			8·0	7·9	7·82	7·86
15		24-pr. do.			5·68	5·62	5·57	5·595
16		13-inch mortar			13·0	12·88	12·8	12·84
17		10 do. do.			10·0	9·88	9·8	9·84
18		8 do. do.			8·0	7·9	7·82	7·86
19		32-pr. carronade			6·25	6·207	6·147	6·177
20		24 do. do.			5·68	5·639	5·584	5·6115
21		12 do. do.			4·52	4·476	4·432	4·454
22	BRASS.	32-pr. howitzer			6·3	6·207	6·147	6·177
23		24 do. do. (Millar)			5·72	5·62	5·57	5·595
24		$5\frac{1}{2}$-inch do.			5·62	do.	do.	do.
25		12-pr. do. (Millar)			4·58	4·476	4·432	4.454
26		$4\frac{2}{5}$-inch do.			4·52	do.	do.	do.
27		12-pr. medium gun			4·623	4·54	4·505	4·522
28		9 do. do.			4·2	4·117	4·082	4·1
29		6 do. heavy gun			3·668	3·585	3·55	3·568
30		Do. light do.						

DIAMETERS.†								Trunnions.			Thickness of Metal.				Chamber.			
D.	E.	F.	G.	G′.	H.	I.	J.	Diam.	Length.	Span.	At Breech.	At Muzzle.	Calibre.	Length of bore.	Length.	Diameters.		Note.
″	″	″	″		″	″	″	″	″	″	″	″	″	″	″		″	
12·53	12·0	11·18	10·35	,,	8·53	10·5	8·05	4·25	4·25	20·01	4·05	1·72	4·62	74·55		Nil.		
11·38	11·0	10·22	9·48	,,	7·8	9·65	7·36	3·57	3·87	18·22	3·66	1·58	4·2	67·74		Do.		
9·78	9·75	9·61	9·0	,,	6·35	8·83	6·75	3·66	3·66	16·58	3·05	1·55	3·66	80·35		Do.		
8·58	8·29	7·7	7·53	,,	5·84	7·57	5·51	2·94	3·5	14·8	2·53	0·95	3·66	57·47		Do.		
8·2	7·5	7·0	6·8	,,	5·1	6·9	5·0	2·7	3·2	11·3	1·92	0·97	2·91	69·2		Do.		
6·8	6·5	6·1	5·6	,,	4·64	6·01	4·35	2·36	2·55	11·3	1·98	0·74	2·91	46·0		Do.		
6·74	6·5	6·1	5·9	,,	4·6	6·0	4·2	2·2	2·6	11·5	2·32	0·62	2·95	45·5		Do.		
[illegible]	6·55	6·05	5·87	,,	4·62	5·8	4·38	2·32	2·36	10·95	2·35	0·73	2·91	34·0		Do.		
5·44	5·1	4·86	4·65	,,	3·74	4·81	3·53	2·21	2·5	10·1	1·85	0·75	2·01	57·98		Do.		
13·58	,,	12·95	12·06	,,	10·2	12·1	9·6	4·62	4·5	22·8	4·3	1·63	6·3	61·16	10·26	6·3	5·0	
12·15	,,	11·53	10·74	,,	9·16	10·93	8·52	4·25	4·25	20·92	3·76	1·43	5·72	55·58	8·76	5·66	4·25	
9·65	,,	9·3	8·75	,,	7·5	9·45	8·6	3·6	3·6	16·5	2·66	1·58	4·58	36·8	6·8	4·52	3·4	
7·34	7·3	8·47	7·73	,,	6·99	8·47	8·17	2·89	3·1	14·67	2·53	1·13	4·52	16·1	5·1	2·26	2·26	
7·34	8·5	8·47	7·73	,,	6·99	8·47	8·17	2·89	3·1	14·67	2·53	1·13	4·52	16·1	4·8	2·26	2·26	
8·15	8·43	7·82	7·37	,,	8·28	8·43	8·25	2·8	3·3	15·0		0·7	5·62	11·92	5·2	5·45	3·1	
7·1	7·34	6·85	6·43	,,	7·1	7·34	7·2	2·26	2·5	12·35		0·68	4·52	10·13	3·9	4·25	2·5	

O. Ordinary.—I. *Intermediate between* M and O; *being Bored-up guns.*

fillets, are not, the diameter given being that of the conic frustrum, or of the cylinder, as the case may be.

TABLE D.

of Shot and Shell; the Minimum exhibiting the greatest Windage possible to insure accurate practice.

Remarks and Observations.

} Shells and hollow shot.

1. The Maximum Guage is a metal cylinder of three diameters in length, through which the shot and shell must pass; the Minimum, a ring through which they must not pass: the difference between the two being a necessary allowance made to the contractors for error in casting; the Minimum Guage also determining when the degradation of the shot or shell shall have proceeded to such a length as to render them unserviceable.

Bored-up gun.

2. The proportion of windage for the older construction of ordnance, viz., Nos. 4, 6, 7, 9, and 11, which is somewhat less than 1-27th part of the diameter of the bore, having been, in consequence of the great improvement in the manufacture of shot and shells, considered no longer necessary, it has been reduced in all new constructions, and varies from 1-32nd to 1-45th part of the diameter of the bore; in no case exceeding ·2 inch, even for the largest guns. The windage for a given nature of ordnance, however, differs with the length of the piece, in order that a greater correctness and precision in practice may be obtained; and in the 32-pounders there are consequently the following varieties; viz., ·233 old construction, ·2, ·175, ·125, and with the carronade, ·073 of an inch.

In the shorter pieces, howitzers and mortars, the windage is, for the same reason, brought to the very lowest practicable limit.

Weights, Dimensions, &c. of Common Shells.

Field Service,
...st.-General &

	13-inch.	10-inch.	8-inch.	5½-inch.	4⅖-inch.
Weight	1 cwt. 3 qrs.	3 qrs. 10 lbs.	1 qr. 12 lbs.	14 lbs. 0 oz.	7 lbs. 0 oz.

ARTILLERY TABLE E.

Table of Pieces of Iron Ordnance which are to be used in the Armament, generally, of Works, Forts, Towers, and Sea Batteries.

No.	Nature of Ordnance.	Length.	Calibre.	Weight.	Charge.	Ranges. P. B.	2°	5°	8°	12°	Recoil.	How mounted.	Remarks.
		ft. in.	in.	cwts.	lbs.	yards.	yards.	yards.	yards.	yards.	feet.		
1	8-inch shell gun	9 0	8·05	65	10	300	1130	1920	2400	3010	6½	Upon traversing or ground platform as required.	This gun to be used with hollow shot, shells, and spherical case, also common case. Useful against shipping, to command roadsteads and approaches, and it may be considered as equal in power to the heavy 32-pounder.
2	8 do.	6 8½	8·05	50	8	210	1050	1800	2250	2870	8½	Ditto	Proposed as a substitute for the 68-pounder carronade for flanks and interior defences; also for commanding landing places. Ammunition as in former case.
3	32-pounder gun .	9 6	6·41	56	10	400	1130	1964	2335	3030	7	Ditto	The power and range of this piece of ordnance points it out as one of the best guns for distant ranges against shipping, &c. Hot shot, in addition to the usual ammunition.
4	32 do. .	6 6	6·3	33	5	360	1050	1740	2200	2800	11½	Upon bracket carriage and ground platform.	This gun is for flanks and all purposes of a shorter range. Ammunition as above, to be associated with No. 3.
5	24 do.	9 6 or 9 0	5·82	50 48	8	400	1100	1850	2240	2960	6½	Upon bracket carriage and traversing or ground platform.	The range somewhat less than from a 32-pounder; but it is a useful gun, and for general purposes hardly inferior to it.
6	24 do. .	6 0	5·75	20	2½	—	750	1280	1750	2200	9½	Ground platform.	For flanks and short ranges: good gun for common and spherical case. To be associated with No. 5. Substitute for 24-pounder carronades in casemates, &c.
7	18 do. .	9 0	5·29	42	6	400	1050	1770	2230	2820	6	As Nos. 1, 3, and 5 . . .	The range of this gun is considerable, and it may be useful against the approaches of boats, &c. It is fitted for the land fronts of works which may be exposed to desultory attack, and where rapid firing may be necessary.
8	18 do. .	6 0	5·17	20½	3	—	765	1300	1780	2250	9	Ground platform.	For flanks and short ranges.—To be associated with No. 7.
9	12 do. .	9 6	4·62	34	4	400	1000	1520	1940	2700	5	Ground platform.	This gun to be used as No. 7. Under many circumstances it will be useful.
10	6 do. .	6 0	3·66	17	2	360	940	1470	1880	2400	4½	Ground platform.	Principally intended to be mounted on saluting batteries.
11	10-inch howitzer .	—	10·0	41	7	—	650	1100	1770	2410	8½	Ground platform.	These powerful pieces may be used for faces, flanks, interior defences, and against enemy's cruizers: their weight is such as to allow of their being moved from place to place as may be required.
12	8 do. .	—	8·0	21	4	—	600	1000	1650	2000	7½	Ground platform.	
13	5½ do. .	—	5·68	15	2	—	730	1200	1700	2175	10	Either on ground platform or dwarf traversing.	A convenient piece on works to move about as necessary, and for towers of weak construction.
14	13-inch mortar .	—	13·0	36	9	—	Extreme range			2900	—	———	No remarks here necessary.
15	10 do. .	—	10·0	18	4	—	Extreme range			2400	—	———	
16	8 do. .	—	8·0	9	2	—	Extreme range			2000	—	———	
17	56-pounder gun .	11 0	7·65	97	16	—	1390	2260	2760	3560	6½	Sliding carriage recoiling on dead blocks and traversing platform.	For positions requiring very distant ranges.

NOTE.—*Iron Carriages and Iron Traversing Platforms.*—The question of the suitability and efficiency of iron garrison carriages and iron traversing platforms for works of defence, not liable to enfilade or direct heavy fire, having been repeatedly entered into, and the trials to which they have been subjected at different times and places having given satisfactory results, it has been considered expedient to maintain the use of such carriages and platforms in the Service, and the Master-General and Board concurring in the opinion expressed in a Report of a Select Committee of Artillery Officers, dated 31st May, 1833, that iron carriages are "considered efficient for the armament of the Coast, and of Fortresses in time of peace, with due precaution that in every strong place there is a sufficient number of wooden gun carriages in store to be employed on the weaker front, or fronts, in the event of a regular attack;"—they direct that the proportions of iron carriages and iron traversing platforms, as compared with those of wood, be regulated accordingly in the Armament of Forts and other defensive works.

OFFICE OF ORDNANCE, *22nd January*, 1844. M/32

The columns 'Calibre' and 'P. B.' have been added to the official document by the Committee; the additional matter from good authority, although the ranges are higher than have been usually given of late years.

ARTILLERY TABLE F.

Table of Brass Ordnance.—Ranges and Application.

	Nature of Ordnance.		Length.		Calibre.	Weight.	Full Charge.	Ranges.							Remarks.
								P. B.	1°	2°	3°	4°	5°	6°	
			ft.	in.	in.	cwt.	lbs.	yards.	yards.	yards.	yards.	yards.	yards.	yards.	
1	12-pr. gun	medium	6	$6\frac{1}{2}$	4·62	18	4								Batteries of reserve and position.
2	9 do.		5	$11\frac{1}{2}$	4·2	$13\frac{1}{2}$	3	300	700	1000	1200	1400			Foot batteries.
3	6 do.	long, or Desaguliers'	7	0	3·66	12	2								
4	6 do.	light	5	0	3·66	6	$1\frac{1}{2}$	200	600	800	1000	1200			Horse artillery; Foot batteries. One supplied to men-of-war of all classes from 120-26 guns inclusive; also to the larger steamers.
5	3 do.	long	6	$0\frac{4}{5}$	2·91	6	1								
6	3 do.	light	4	0	2·91	3	$\frac{3}{4}$								
7	3 do.	colonial	4	0	2·95	3	$\frac{3}{4}$								
8	3 do. . . .	mountain	2	$7\frac{4}{5}$	2·91	$2\frac{1}{4}$	$\frac{5}{8}$								
9	1 do. . . .	do.	5	0	2·01	$2\frac{1}{2}$	$\frac{3}{8}$								
10	32-pr. howitzer . .	Dundas	5	3	6·3	$17\frac{1}{2}$	3	370		735		1110		1430*	Attached to 12-pr. batteries of reserve and position; good gun for spherical case.
11	24 do. . .	Millar	4	$8\frac{1}{2}$	5·72	12	$2\frac{1}{2}$	200	450	650	850	1025			Attached to 9-pr. batteries, and to those of reserve and position. One supplied to men-of-war of all classes from 120-70 guns inclusive.
12	12 do. . .	Millar	3	$9\frac{1}{10}$	4·58	$6\frac{1}{3}$	$1\frac{1}{4}$		400	600	800	1000	1110†		Attached to 6-pr. foot batteries, and horse artillery.
13	$4\frac{2}{5}$ do. . .	Coehorn	1	$10\frac{3}{5}$	4·52	$2\frac{3}{8}$	$\frac{1}{2}$								
14	$4\frac{2}{5}$ do. .	mountain	1	$10\frac{3}{5}$	4·52	$2\frac{1}{2}$	$\frac{1}{2}$								
15	$5\frac{1}{2}$-inch mortar . . .	Royal	1	$2\frac{1}{3}$	5·62	$1\frac{3}{4}$									
16	$4\frac{2}{5}$ do. . .	Coehorn	1	$0\frac{2}{5}$	4·52	1									

* 8° .. 1770 yards.
10° .. 1980 „
12° .. 2280 „
14° .. 2580 „

† $5\frac{1}{2}$° .. 1150 yards.

ARTILLERY TABLE G.

Depression of Guns mounted upon Garrison Carriages.

					Degrees.	With elevating screw alone. Degrees.
Carriages, Garrison.	Gun, upon wood coin.	Wood carriage.	8-in.	65 cwt.	$3\frac{1}{4}$	
			32-pr.	56 „	5	
			24	50 „	3	
			18	42 „	$3\frac{1}{4}$	
			12	34 „	2	
		Iron carriage.	32-pr.	56 cwt.	4	
			24	50 „	4	
			18	42 „	4	
			12	34 „	$3\frac{1}{4}$	
	Carronade, block trail.	Wood carriage, upon wood coin.	68-pr.	. . .	9	$4\frac{1}{2}$
			42	. . .	$7\frac{1}{2}$	2
			32	. . .	7	2
			24	. . .	$6\frac{1}{2}$	2
			18	. . .	6	
			12	. . .	5	
		Iron, upon depression block and elevating screw.	24-pr.	. . .	14	$3\frac{1}{2}$
			18	. . .	15	$0\frac{3}{4}$
			12	. . .	16	2
	Howitzer, wood, upon the head of elevating screw and iron swing bed.		10-inch iron	.	1 *	
			8 „	.	$7\frac{1}{2}$ *	

N.B.—Several of the gun and carronade carriages at Gibraltar and St. Helena are mounted in a peculiar way, to give about 25 degrees depression.

The 56-pounder gun has never been mounted, except on a low traversing platform.

This gun, as well as all others, when mounted on traversing platforms, will give about $2\frac{1}{2}$ degrees more depression than when on common garrison carriages.

The preceding, Table G, gives the depressions as arranged to the present date; the following, Table H, shews those proposed for the future, assuming the height of the genouillère at 2 ft. 3 in. or 2 ft. 4 in., that all garrison guns may fire conveniently over it; and corresponding changes are contemplated in the construction of garrison carriages, so as to bring all guns to an uniform maximum Elevation of 10°, and a Depression of 2°;—this last as supposed to be sufficient for ordinary purposes, and all to be obtainable from the common coin. But when, as in case of towers, flanks of bastions, &c., &c., depressions to $6\frac{1}{2}$° or 7° are often necessary, so as to be able to take up ground beyond the effective range of musketry, the additional coin must be used. The carriage would possibly admit of more than the above, but the experiment would be hazardous without cap-squares.

The greatest depression that can be allowed with safety to 18, 24, 32-pr. garrison carriages, (which are all without cap-squares,) wood or iron, is 7° on traversing platforms, and $6\frac{1}{2}$° on ground platforms.

All elevations and depressions in Tables G and H refer to the horizon, and not to the platform.

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* Cap-squares are provided to effect this. In the Plate of the carriage for this piece, it is given as with iron trunnion boxes, since superseded by cap-squares. Vide 'Carriage,' Pl. IV.

ARTILLERY TABLE II.

A Table of the proposed Height, Elevation, and Depression, of the following Ordnance, mounted upon Common Garrison Carriages.

			Elevation upon			Depression.			Height.					
			Stool bed laid on axle-tree.	Stool bed.	Block of carriage.	With elevating screw and depressing block.	With elevating screw.	With common coin.	From platform to axis of gun.		Under swell of muzzle at greatest depression.		Under swell of muzzle at 5 degrees depression.	
			°	°	°	°	°	°	ft.	in.	ft.	in.	ft.	in.
Carriages. Guns.	Wood.	8-in. of 65 cwt. and 9 ft.	16	10	„	„	„	2	3	5½	„		2	7¼
		32-pr. 56 „ 9½ „	16	10	„	„	„	2	3	6	„		2	7¼
		24 50 „ 9½ „	16¾	10	„	„	„	2	3	5⅝	„		2	7¼
		18 42 „ 9 „	18	10	„	„	„	2	3	4⅞	„		2	7¼
		12 34 „ 9 „	18¼	10	„	„	„	2	3	4	„		2	7¼
	Iron.	32-pr. of 56 cwt. and 9½ ft.	„	9½	„	„	„	2½	3	6	„		2	7¼
		24 50 „ 9½ „	„	10	„	„	„	2	3	5¾	„		2	7⅜
		18 42 „ 9 „	„	10	„	„	„	2	3	2	„		2	4⅜
		12 34 „ 9 „	„	10	„	„	„	2	3	1½	„		2	4¾
Howit., wood.		10-in. iron	„	15	„	„	1	„	3	5	„		2	5½
		8 „	„	16	„	„	7½	„	3	3½	„		2	6
Carronade.	Wood.	68-pr.	„	„	14	„	5½	„	3	7¼	2	8⅞	2	9½
		42	„	„	14½	13¼	3½	„	3	3¼	2	3⅛	2	7
		32	„	„	17	14	3½	„	3	1¾	2	2⅜	2	6⅜
		24	„	„	18	13	2	„	3	0½	2	2¾	2	5⅞
		18	„	„	19	13	P.B.	„	2	10½	2	1⅝	2	4⅜
		12	„	„	19	12	P.B.	„	2	8¾	2	1⅜	2	3⅜
	Iron.	24-pr.	„	„	12½	14	2½	„	2	11¼	2	0¾	2	4⅝
		18	„	„	12¾	15	2½	„	2	10	2	0¼	2	3⅞
		12	„	„	15½	16	2		2	9½	2	0⅝	2	4⅛

ARTILLERY TABLE I.—Composition of Field Batteries.

Number and Species of Carriages, of which Horse Artillery, or Field, Batteries of each nature are composed.

	Field batteries.				Colonial batteries.				
							Mountain.		
Nature of batteries	pr. 18	pr. 12	pr. 9	Lt. pr. 6	pr. 3	pr. 3	pr. 3	pr. 3	pr. 1
Nature of howitzers	in. 8	pr. 32	24	12	$4\frac{2}{5}$		$4\frac{2}{5}$	$4\frac{2}{5}$	
No. of guns	3	5	5	5	3	4	3	3	4
Howitzers	1	1	1	1	1		1	1	
Ammunition Waggons — Guns	9	10	7	6	6 carts	4 carts	*	*	*
Ammunition Waggons — Howitzers	4	2	2	2	2 carts				
Spare carriage	1	1	1	1					
Waggon — Forge	1	1	1	1	†	‡	‡	‡	‡
Waggon — Store	2	2	1	1					
Waggon — Platform	1								
Store carts	1	1	1	1	§	‖	§	§	§
Total carriages	23	23	19	18	12	8	4	4	4
No. of rounds per gun	180	148	166	223	154	165	165	108	232
" per howitzer	112	114	144	236	80		96	72	

The composition of the howitzer batteries seems not to have been as yet decided on.

Composition of Batteries.

1st. The batteries are composed of five guns and one howitzer, with the exception of 18-pounder batteries, which are to consist of three guns and one 8-inch howitzer.

2nd. In case of reserve batteries consisting of howitzers only, to consist of six pieces and their appropriate carriages.

Rounds per piece.

3rd. The number of rounds per piece required to sustain an action of some duration has been assumed as a criterion to regulate the ammunition waggon to accompany a battery of each nature, independent of reserves.

Distribution of Ammunition.

Common Case.

4th. Adhering to the uniformity of packing, and the power of substituting one limber or waggon for another, the old proportion of case shot was considered too great; a diminution of it has taken place, and that which is to be retained is to be of one sort, viz., 41 balls in tins for guns, which has permitted an increase in the number of rounds. The case shot for howitzers to be not less than 4-oz. balls.

Spherical Case.

5th. The spherical case is less efficient in the lower natures than the higher, and is altogether useless in the 3-pounder; the average proportion of it to the total number of rounds per piece is nearly as follows:

---

* Ammunition carried on mules' backs.

† There ought to be a small forge for this battery, carried on two mules.

‡ A forge on back of two mules.

§ There ought to be a small cart drawn by two mules, for a spare wheel, mules' shoes, stores, and tent, &c.

‖ Two mules, for mules' shoes, stores, and tent.

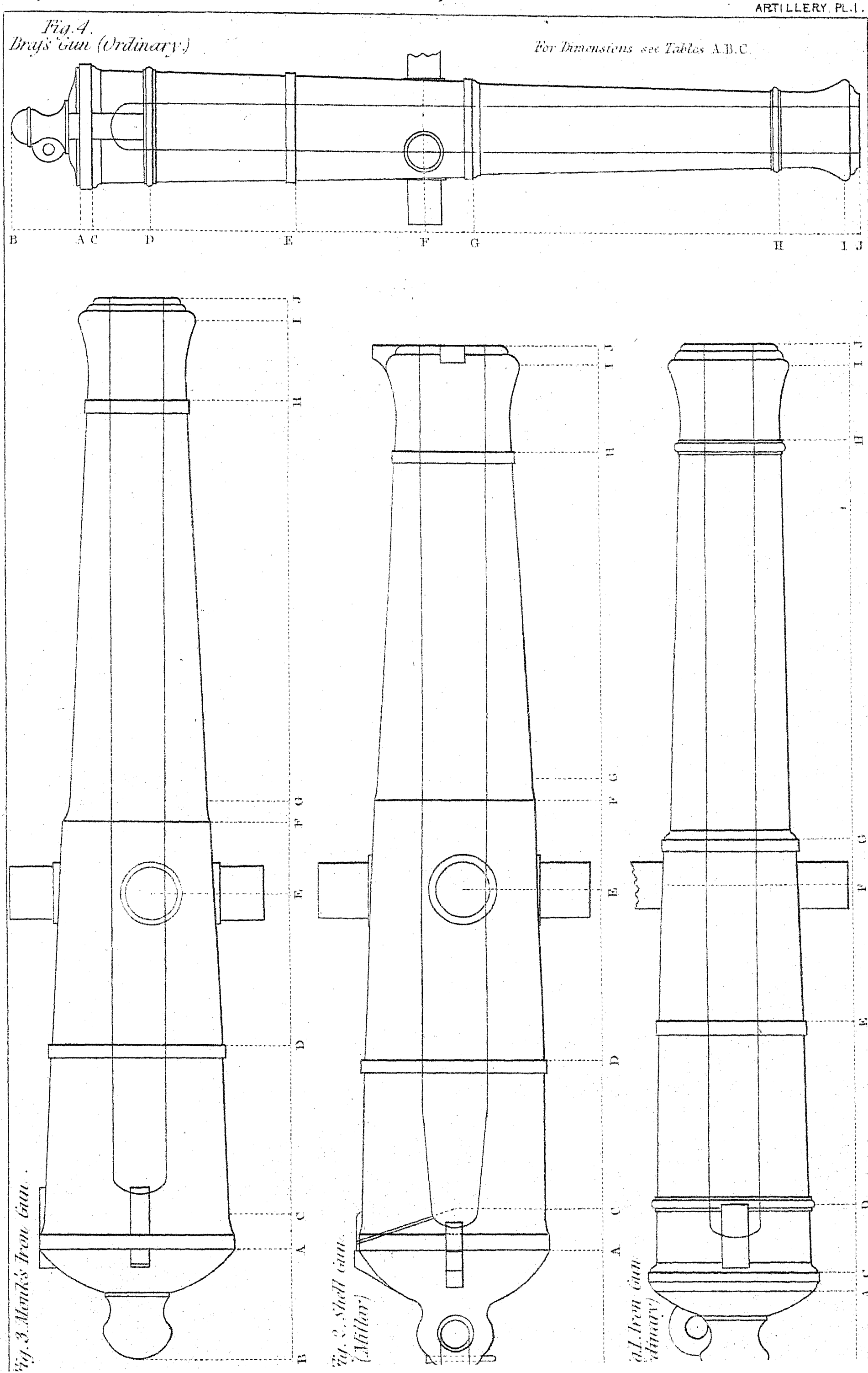
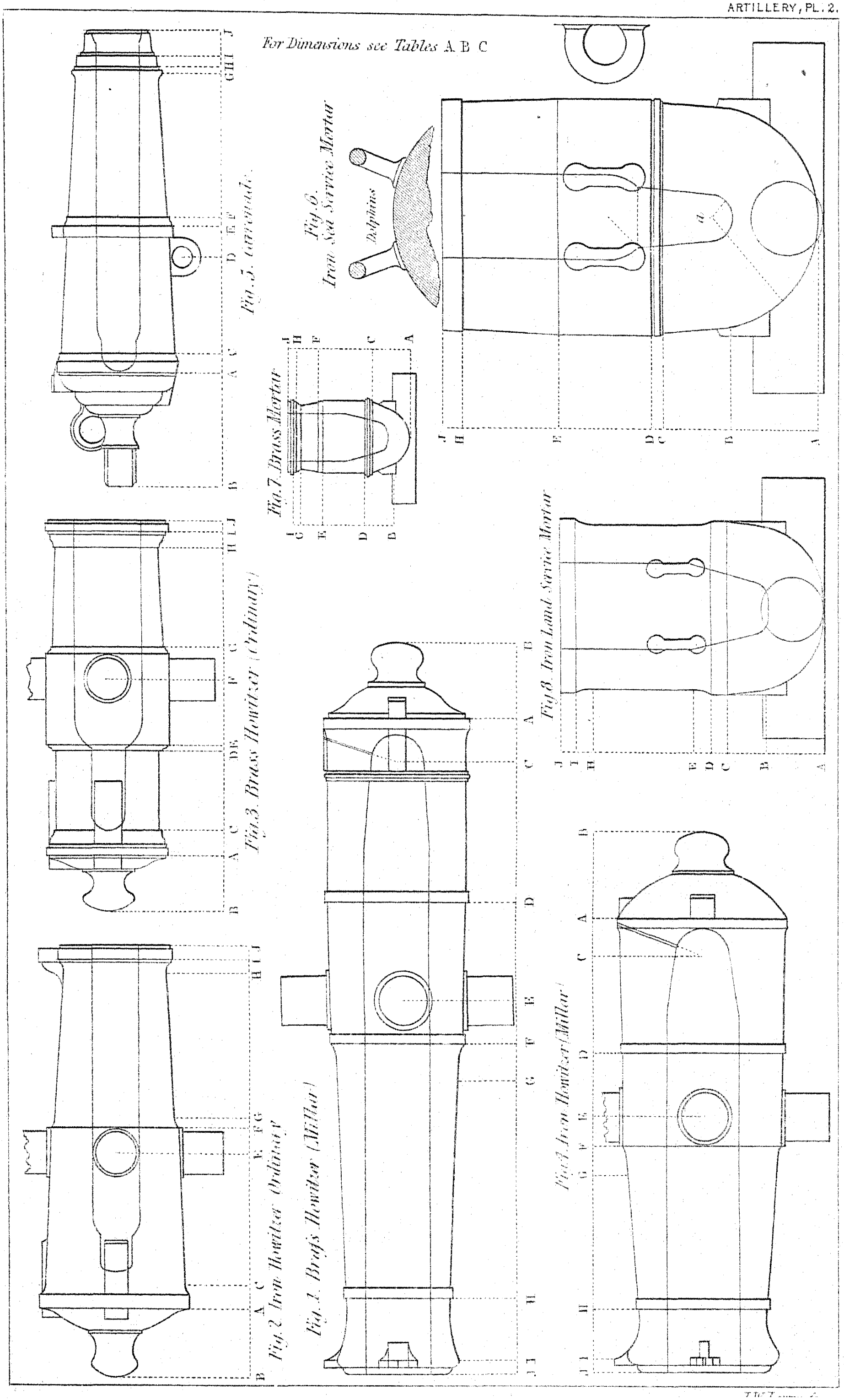


Fig. 4.
Brass Gun (Ordinary.)
For Dimensions see Tables A.B.C.
B A C D E F G H I J


For Dimensions see Tables A B C
Fig. 5. Carronade
Fig. 3. Brass Howitzer (Ordinary)
Fig. 2 Iron Howitzer (Ordinary)
Fig. 1. Brass Howitzer (Millar)
Fig. 7. Brass Mortar
Fig. 6. Iron Sea Service Mortar
Dolphins
Fig. 8. Iron Land Service Mortar
Fig. 4 Iron Howitzer (Millar)

Spherical, Spare Ammunition.

Colonial Service.

Shaft to Trail.

8-inch, 32-pounder, 24 ,, 12 ,,	howitzer	$\frac{1}{2}$
18-pounder gun	. . . .	$\frac{1}{4}$
12 ,,	. . . .	$\frac{1}{3}$
9 ,,	. . . .	$\frac{1}{4}$
6-pounder, light	. . . .	$\frac{1}{8}$

6th. The proportion of ammunition embarked for three months' consumption to be at least four times the quantity immediately accompanying each battery.

7th. A scale of equipments is added for smaller ordnance for local circumstances, such as light 3-pounder 4 feet, and Coehorn or $4\frac{2}{5}$-howitzers on carriages of single draft, and carts for ammunition, and also for the 1-pounder ammuzette. These pieces are particularly adapted to the West Indies and other Island Services, where the limited movements they have to make must be regulated by the draft of mules or by the assistance of men.

8th. Scales have been formed for Mountain Service according to the two modes in most frequent use of the 3-pounder and Coehorn and $4\frac{2}{5}$-howitzer of that construction, viz., the one by pack-carriage altogether, and the other by draft, a shaft carried by a mule attached to the trail of the gun carriage.

9th. The latter mode (the shaft to trail) is infinitely to be preferred, as being easier for the mule, more readily brought in and out of action, as conveying more ammunition with the same power, and being able to move on almost any road over which the former is capable of being transported.

10th. That of pack-carriage is quite ineligible, and ought only to be resorted to when there is no other resource. The gun weighs 252 lbs., and the howitzer 280 lbs. This dead weight is concentrated on the top of the mule's back, and if by a false step or motion of the animal, the weight inclines over the one side, the pack-saddle turns round and comes under the mule's belly; the piece cannot be put on the saddle without the greatest exertion of the men, and even then, it requires that the animal should stand perfectly motionless.

Vide 'Equipment,'—'Artillery,'—'Mountain;' and 'Carriage,' Plate XXIX.

ARTILLERY TABLE J.—Rockets.

General Memoranda on the Elevations, Ranges, and Lengths of Fuze at which the Shell may be expected to burst in the new-pattern Rocket, in which the hollow head serves either as Shot or Shell.

Lengths of Composition.	24-pounder.		12-pounder.		6-pounder.		3-pounder.	
	Elev.	Range. yds.	Elev.	Range. yds.	Elev.	Range. yds.	Elev.	Range. yds.
If the whole length of the fuze be left in the shell . . .	47°	3300	40°	3000	37°	2300	25°	1800
If the whole of the fuze composition is bored out, and the rocket composition left entire	27	2000	20	1500	15	1100	12	850
If the rocket composition be bored into within one inch* of the top of the cone	17	700	10	420	10	420	8	420

N. B.—The above have not as yet been confirmed by any extensive course of practice.

* In the 24-pounder $1\frac{1}{2}$ inch.

ASSAULT.—The detail of Special Assaults, as regards the duties of an Engineer Officer, are explained in the articles 'Attack of Fortresses,' 'Attack of Posts,' and 'Escalade;' but the general disposition of the troops, and arrangements for the success of Assaults—whether in the Attack of open, or of walled, or fortified towns; or of intrenchments, fortified positions, or camps,—demand a separate Paper; and require that the subject be especially submitted to the consideration of persons who may be entrusted with the guidance of such an important operation in the Field.

It is now proposed to suggest such a course as will probably lead to success; or else support the Assault if checked or defeated.

1st. That the Officer commanding and responsible for the operation should be in immediate communication with the troops during the Assault; and be present with the reserve or supporting party.

2ndly. The troops destined for this duty should be divided into two portions, *each* equal in strength to three-fourths of the garrison attacked; one portion being the attacking party, and the other half the reserve, or supporting party.

3dly. Each column of the attacking party will also be subdivided into advance—main body—and support, whatever may be the number of these columns.

4thly. The disposition of the attacking party, as it reaches the point attacked, will be regulated by the Engineer Officer, subject to the Officer commanding; the necessary reconnoissance having been made by them, and the party furnished with tools, ladders, and proper implements, adapted to the circumstances of the moment, as well as being accompanied by a detachment of Sappers.

5thly. The disposition of the reserve, equal, as before observed, to the whole attacking force, should be regulated by the Officer entrusted with the execution of the Assault; and this reserve should be accompanied or not, according to circumstances, by Cavalry and Field Artillery. When these descriptions of force are present, the former should be placed under cover or out of gun-shot, about 1500 yards; the latter should be kept in hand until the attacking party is engaged, when the guns should be spread out on the flanks, and open a vigorous fire upon the works;—the Infantry, brought immediately in rear of the attacking portion under cover, if possible, from fire of grape and musketry, halted until the issue of the first assault is seen.

6thly. It is impossible to regulate an Assault by any minute suggestions for the advance, except to observe that it is usual for each column to attack the salient points of the works, and least defended portions of the place;—to throw out skirmishers and firing parties in front in any cover available, and keeping up a rapid and compact fire upon the defenders;—to follow with the Sappers and Grenadiers to force all obstructions; and then to advance the main body,—the supports of each body judiciously planted in the rear.

Eventually, as success occurs, and the whole move on, points of security should be taken up, such as the reverse, or the exterior slope, of the works; buildings, walls, as well as gorges, and flanks, which frequently give cover. Men should be planted under an Officer with instructions to take no notice of the pêle-mêle, but to keep up a heavy firing in front; employing the Sappers in intrenching the position taken up by the supporting party, or in collecting waggons, carts, carriages, &c., &c., capable of being made into a barricade.

7thly. Either in the supposition that the success of the Assault is doubtful, or that there is a check, or a repulse,—the reserve, in the first case, to render success doubly sure, should move forward under the Officer commanding the whole force, and relieve the assailants; the original attacking party taking their place as reserve

as soon as order can be restored;—the Artillery, brought into position in the openings, between the advancing columns, and directed upon the retreating or resisting forces; and if success is final and complete, the Cavalry, in event of their being employed, will also move forward, either through the openings cleared, or by a detour, if a fortified town, in pursuit.

In the second case, that of a check, the reserve, on the reconnoissance of the Officer commanding, will either move forward in support of the Attack, or to cover the retreat, if further perseverance in Assault is deemed impracticable; the Artillery and Cavalry being warned as to the intention.

In event of the Assault being repulsed, the reserve, which should be in échellon of corps, having advanced guards in front, will allow the retreating party to move through the intervals, and the advanced guard will endeavour to check the pursuit: if overpowered, they will fall back on the reserve, and the whole may in that manner retreat until beyond gun-shot,—there endeavouring to make a stand, repulse the garrison, and if possible convert failure into success, if the pursuit has been badly conducted and without due caution.

The Artillery will retire as soon as it is certain that failure has occurred, and, by a new position, cover the retreat. The Cavalry will also retire, and check any advance of a similar force of the pursuing party.

Lastly. As an important rule in all Assaults, the composition of the forces should be by regiments or corps, and not by detachments: also, each Non-Commissioned Officer should be provided with the means of spiking a gun, for which purpose even an old nail is sufficient.

The points here noticed are of importance in all Assaults, except in partial attacks, as on an outwork, or any particular work in which a lodgement is to be made; local circumstances then regulating the *time*, the *number* employed, and the *mode* of execution.

The necessity of a sufficient reserve, ready and at hand, in support of the assaulting party, each equal to three-fourths of the garrison, or force, attacked—and of the immediate presence of the Officer commanding, in connection with the attacking force, is inferred from the recollection of our want of success at Buenos-Ayres, and at Bergen-op-Zoom. By the arrangements suggested, an unsuccessful attack may be rendered less disastrous; and prevent checks and difficulties when on the point of gaining the object.

It frequently happens, that troops led to the Assault obtain a partial success, and then are at a loss how to proceed: no responsible person being present to direct further operations, there is a pause,—the defending party rallies—attacks in its turn,—then comes a retrograde movement—confusion, and finally—defeat. Should, however, *the Reserve, together with the* RESPONSIBLE HEAD, *be at hand,* these untoward events are not likely to occur; for as soon as success is apparent, the Reserve advances, further orders are given, and final success is the probable result.

Indeed, Assaults, *if feasible*, would seldom fail with these precautions; and there are few posts but what are open to assault, by taking the proper opportunity. And no Officer entrusted with the defence of a place should consider himself secure without unremitting vigilance, except in such cases as works surrounded by deep water, impassable marshes, or by walls or precipices at least 37 feet high; or where the approach is by a narrow causeway, easily watched.

G. G. L.

ATTACK.*—By Major-Gen. Sir J. F. Burgoyne, R.E.

ATTACK OF FORTRESSES.

NUMBER OF TROOPS FOR A SIEGE.

The attempt to lay down a scale for the number of troops required for a Siege, in proportion to the size of the place or strength of its garrison, must be delusive. In one case double the number of the garrison may be sufficient, while in another six times its force may be inadequate.

The calculation will depend upon many contingencies; among the principal are,

1. Whether the besieging army will have any exterior force to guard against.
2. Whether the inhabitants of the adjoining districts are friendly or hostile; and if the latter, the extent of their energy, or power of annoyance.
3. Whether the garrison would be favourably circumstanced for making sorties, or the reverse.
4. The extent of labour and duties which would be required of the besieged, in proportion to the strength of the garrison.
5. The quantity of work and duties that would be required of the besieging force.
6. Facility or otherwise for procuring timber, brushwood, means of transport, and other accessories, in the neighbourhood.
7. Abundance or deficiency of Artillery and Ammunition, as well of Engineers' or Sappers' tools and stores, will influence in a great degree the number of troops of the Line necessary.
8. Consideration of the means of the besieged in the same particulars.

The Commanding Engineer, if well informed on the nature and circumstances of the place, as it is to be presumed he would be, would form his project of attack in detail, and calculate from the above and other considerations the force necessary for the operations.

Every species of service and duty must be brought into account, but the principal ingredient will be the number of men that must be daily actually *in* the trenches, for *guard* of the works or working parties, as well for Artillery as for Engineers giving them the proper number of reliefs.

If the Besieging Army was equal only to eight times the average number required constantly in the trenches, the service would be very hard; it would be equivalent to an assumption of each man having eight hours' working party duty, or twenty-four hours' guard actually in the trenches every fourth day;† but in fact, from the number of men who never do that duty, such as cavalry, bands, orderlies, servants, men in charge of horses and sick, &c., the duty would be found to come at least once in three days, or probably nearer to every other day, upon the remainder, which would be far too severe.

The distance which many of the troops will have to march from their encampment to the trenches must also be considered.

The camp and fatigue duties, foraging, and procuring and preparing materials for the siege, would afford heavy work for the proportion not in the trenches.

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* This article chiefly comprehends general principles: the chief details will be found under such heads as 'Battery,'—'Sap,'—'Mining,' &c.

† This calculation is on the assumption of half the number being guard, and half working party: as these proportions are altered so will be the calculation; and also, if the working parties are relieved every twelve hours instead of eight.

The Cavalry do no duty in the trenches, but will be proportioned to the service required for orderlies, escorts, maintaining communications also for dispatches, and pickets to oppose any sorties that may be expected to extend to any distance from the fortress. They are also employed in collecting materials for the siege, particularly any that are small in bulk, and can only be obtained at a distance, such as brushwood of best quality, and in particular that fit for gads or bindings for the fascines.

The Artillerymen must be proportioned to the force of the batteries, and should be in sufficient numbers to take upon themselves all that service that requires peculiar instruction and exercise, without occasion for other assistance from the Line than is wanted as ordinary manual labour, of which at times they will require a considerable amount.

OFFICERS OF ENGINEERS.

The smallest siege of a fort will require nine; that is, three brigades of two each and three Staff.

If the operation be somewhat larger, and to last ten or twelve days, there should be twenty Officers.

A regular hexagon attacked on the principle of Vauban would need forty Officers.

Sappers and Miners cannot be in too great numbers: if perfectly efficient and well trained, each Sapper in a Siege will be worth three men of the Line up to a certain considerable number. They should, if possible, do every species of trench-work, excepting what is of the most ordinary character; and by the facility and regularity with which they would perform it, a great deal of time would be saved, fewer men be required in the trenches, and much fewer casualties occur.

Each brigade of Officers should have the assistance of six men, to lay out the works and keep the working parties to a correct performance of their task.

Each head of a Sap, allowing for regular reliefs, will require twenty-four.

For revetting batteries, six men per gun.

Of the parties making fascines and gabions, one-fourth should be Sappers, particularly at first.

The following may partly be made up of artificers from the Line.

For preparing and afterwards laying platforms, four carpenters each.

For each gallery of a mine, requiring support by frame-work, four carpenters.

These two last suppose the plank and wood to be ready prepared, at least in the rough.

For cutting out sleepers and planks in the woods, two pair of sawyers, per pit, should produce one platform from each pit in two summer days, including cutting down and trimming the trees, &c.

For a moderate siege of a fortnight or three weeks, where twenty Officers of Engineers and twenty-five pieces of artillery are employed, the number of Sappers should not be less than 400.

A front of fortification attacked, according to Vauban, would require at least double the number, besides Miners in addition, where necessary.

Where they are not in sufficient numbers, a selection of artificers from the Line are attached to the corps for the siege, and receive such hasty instruction as can be given to them; but they are far inferior to Sappers.

As we know from experience that the Sappers can become as well disciplined and good soldiers as any other troops, they would act as perfectly efficient battalions, during periods of movements of the army in which their peculiar services as Sappers would not be required; while for attack or defence of posts, throwing up intrenchments, passage of rivers, forming or destroying bridges, &c., &c., their services would be invaluable.

There is a greater reason for a large proportion of Sappers, as, in an ordinary campaign, the nature of their duties will probably lead to greater losses than sustained by soldiers of the Line.

Although men from the Line instructed for the occasion will be but a very imperfect substitute for regular Sappers who have a thorough knowledge of their business, they would be extremely useful to assist them in the artificers' works, and for performing various operations that require a greater degree of knowledge and intelligence than can be expected from the soldiers who may be found promiscuously in the working parties.

From 200 to 600 (according to the class of siege) of such men selected, paid and encouraged, and attached for the siege to the Engineer Department, would expedite the operations, lead to a reduction in the numbers required for the ordinary working parties in a far greater number than their own force, and enable the works to be more perfect.

STORES.

The Artillery and Stores for a siege-train in general might, perhaps, be conveniently arranged in *proportions*, commencing with a small one for attacks of forts or small posts.

The details for the Artillery Service are for the consideration of that particular branch; but 25 or 30 pieces of heavy ordnance, including about 13 mortars and howitzers, with about 1000 rounds of ammunition per gun, and 500 per mortar and howitzer, might be considered as one proportion adapted to very small sieges; to be multiplied according to the probable exigencies of the anticipated campaign.—*Vide* 'Artillery,' Section v.

The following may be esteemed a reasonable proportion of the principal Engineers' stores for the smallest siege.*

List of Engineers' Stores forming one proportion for a small Siege.—Some of the weights are estimated only.

Actual weight by experiment. cwt.	lbs.			Estimated weight. cwt.	lbs.
		2000	Pickaxes ($\frac{1}{10}$ pole or Miners' picks) . . .	182	0
		1800	Shovels	93	0
		200	Spades	10	0
13	0	200	Felling-axes.		
3	80	50	Broad axes.		
40	0	2200	Spare helves for different tools.		
7	56	300	Bill-hooks.		
0	56	5	Pit saws.		
1	0	10	Cross-cut saws.		
1	10	60	Hand saws.		
1	8	30	Adzes	8	0
		30	Augers		
		30	Two-feet Rules		
		30	Planes		
		3000	Spike nails		
		2	Boxes of nails of sorts		
7	71	30	Crow-bars.		
5	39	30	Sledge hammers or pin mauls.		
		30	Gabion knives.		
		60	Topping-axes.		

* Vide 'Equipment,'—'Siege,'—'Engineer.'

Actual weight by experiment. cwt.	lbs.		Estimated weight. cwt.	lbs.
		10 Sap forks	9	0
		90 Earth rammers		
		* 2 Chests of Carpenters' small tools	4	0
		* 2 Do. of Masons' and Miners' do. do.		
		* Miners' large tools for 3 Brigades	3	0
		* Masons' do. do. for 6 Brigades	6	0
254	0	20,000 Bushel sand-bags.		
7	0	60 Fascine choakers.		
		25 Gun platforms, 18 ft. × 12	650	0
		5 Mortar do. 8 × 8	42	56
		1 Forge cart, with Smiths' tools	80	0
		Coals and steel for repairing tools	12	0
		2 Hand-screw jacks	7	0
		2 Large double-blocks and tacles		
		2 Coils of 3-inch rope		
		2 Ditto 1½ ditto		
		150 Platform screws, with nuts	3	0
		2 Steelyards, complete	6	0
		10,000 yards of Hambro' line, for tracing works		
		10,000 yards of broad white tape, for night do.		
		100 yards of saucisson or powder hose, made up		
		100 yards of canvass for do. or other purposes		
		Files, Setters, Dogs, Boxes, Chalk lines, Grease, &c.. for Saws of all sorts		
		30 Masons' Levels	18	0
		40 Plumb-bobs, with lines		
		30 Dark lanthorns		
		300 lbs. of Candles for do. and Miners		
		20 Grind-stones		
		20 Rub or Whet-stones		
		Twine, coarse, Packing-needles, &c.		
36	0	21 Marquees.		
		21 Bell tents.		
		Plans, Papers, Books, Instruments, &c.	6	0
		180 Joints of scaling ladders, 10 feet long each	100	0
		4 Large tarpaulins	4	0

When the stores are to be conveyed by water, whether by sea, or river, or canal, and that means of transport are consequently plentiful, the stores may be greatly increased, and the service much expedited thereby. Platforms, timbers, and even fascines and gabions, can in such case, perhaps, be prepared previously, and at a distance, and conveyed to the siege.

Under any circumstances, a large proportion of every description of the small stores should be included, because they are easily carried, and may add much to the facility of the operations.†

* Chests of tools are no longer supplied: assortments are demanded as required.—*Editors.*

† The preceding list makes no allowance for casualties; there must be ample provision made for such stores as bill-books, shovels, sand-bags, &c., &c., which are always liable to be purloined;—and every practicable arrangement made to prevent such losses.

All these estimates of men and means are given as what are considered most appropriate and desirable, without being at the same time extravagant. Where exigencies of the Service require operations to be performed by smaller means, which is too often the case, of course the attempt must be made with alacrity, and the best made of those that may be available up to a certain point, when it may be the duty of the Commanding Engineer to declare them to be insufficient to afford any reasonable prospect of success.

INVESTMENT, ENCAMPMENTS, AND LINES OF COUNTER AND CIRCUMVALLATION, &c., UP TO THE OPENING OF THE TRENCHES.

The Investment is usually effected as much by surprise as possible, in order to shut the place up in as unprovided a state as may be.

It need not be complete (in occupying the entire circumference round the place), but it should be efficient; that is, the garrison should be shut up from receiving any succour, either in men or means, that can be of important service to it, or from a power of acting upon the flanks of the approaches.

At the siege of Badajos, in 1811, the right bank of the river was left open to the garrison for a few days, which was of no consequence as regarded any succour to be obtained from thence; but it gave a power which was taken advantage of, to run out guns day by day, which at a long range enfiladed the trenches.

The Encampments will very seldom be in the formal precise order found in the old books of Attack and Defence, of a circle round the place just out of gun-shot; but in the different positions which the country shall present as most favourable for the convenience of the Troops and the Service, that each part may be called on to fulfil. An important passage that may be likely to be attempted to be forced, either from within or without, will naturally be taken up in the manner that shall present the strongest features for defeating such attempts.

In occasional situations, it may be desirable to draw the encampment somewhat close to the place: favourable undulations of ground may enable this to be done with security and to great advantage. In others, the troops may be at a greater distance, in positions favourable for other objects.

The same reasoning applies to Lines of Circum- and Counter-vallation, the effect of which would generally rather be obtained by adapting the position of the troops and defences to the features of the country under the ordinary principles of military positions and intrenchments, than to a regular circular line round the place, the applicability of which under the present mode of warfare can scarcely be conceived.*

Other considerations having been provided for as above, it will be the endeavour to bring the encampments of the several parts of the besieging force as convenient for reaching the trenches as possible; as large a body of troops as can be allotted to one part will be encamped on the side to be attacked, in order to give peculiar security to the parks of artillery and several dépôts, and also to be more at hand for the duties of the siege.

The principal Engineers' Dépôt will be out of easy range from the garrison, and not only out of sight of it, but the access to it for stores and materials from different directions, as much as possible, not to be perceived.

The parks of artillery must be peculiarly secured from risk of exposure to the fire from the garrison.

The fatigue of marching between the remote parts of the encampments and the trenches is so great an addition to the duties of the siege, that it will be an im-

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* Vide 'Blockade.'

portant study, and worthy of some labour, to render the communications between them, in addition to being good and complete in bridges, &c., &c., *as short* as possible, consistent with security.

At the blockade of Malta, in 1800, advantage was taken of the ordinary loose stone-wall fences of the country; and by connecting and raising those that were convenient and parallel to the works, by closing gaps, and opening cross-walls, to effect a communication all round the fortress, in many parts not more than 200 or 300 yards from the place; and though only a screen, still being hidden from view, was perfectly secure, and of great service. It was more costly and inconvenient to the garrison to destroy this screen than to the blockading force to maintain it.

In Fortresses besieged, a screen of mere canvass across narrow openings that were exposed to musketry, has frequently enabled the communication to be maintained free and secure.

Hollow roads, covered ground, buildings, walls and hedges, &c., might, under many circumstances, be connected artificially into communications covered from view, that would be of great service in this way.

From the period of the first investment to the opening of the trenches, every necessary reconnoissance of the place is made by close investigation of the Officers of Engineers, who are to be protected while executing this service by covering parties of the troops.

The Plan of Attack is definitively arranged; the situations for the additional troops that will be brought to the immediate neighbourhood of the attacks, as well as of the several dépôts marked out, and as many points fixed and marked for the approaches and works of the siege in detail as possible; always under the greatest precautions against the garrison obtaining a knowledge of the proposed operations.

From the first period of the investment also, parties will be sent out to collect platform timbers, fascines, gabions, &c., &c., which will be brought in so far as can insure subsequently the least possible extra carriage to the final dépôts in rear of the attacks.

This will require the continued service probably of all the means of transport that brought up the stores in the first instance; and as the horses or cattle so employed must be subsisted in the district itself, in addition to Cavalry, Artillery, &c., will tend among others to shew how many more difficulties are presented to carrying on a siege in winter, than merely the effect of climate on men and animals.

OBJECT AND PRINCIPLES OF ATTACKS.

To ascertain what works will be necessary for any siege, it may be well to revert to first principles.

The object to be obtained in the Attack of a Fortress is to make a breach or passage in its walls, capable of allowing it to be stormed with superior forces.

If the place has only a single line round it, and that exposed to view to the foot, or very near it, a single battery, established at from 200* to 400 yards distance, may be sufficient to effect the breach, and the troops then storm the place at once.

Unless there should be natural cover up to the site of the battery, a covered approach must be made to it for the troops; the guns are taken by the most convenient roads or directions, independent of the approaches, during the night.†

* Practicable breaches may be made from greater distances, by increasing the power of Artillery, and by an extension of time.

† It happens sometimes that daylight comes on while this is in operation, in which case any gun that may necessarily be left in an exposed situation is covered from view, as well as may be, by branches of trees, &c., &c., till the next night, and thus sometimes escapes observation.

In proportion to the fire of artillery that the garrison can bring to bear upon the single battery, will be the difficulty of effecting the breach; or the breach may have a flanking fire to bear upon it, (and a very small flank will have a powerful effect on the assailants): in either event these means of resistance, if too powerful, must be previously silenced or greatly reduced, which must be effected by other batteries, and probably some works carried nearer.

When the garrison is in sufficient number, and has facilities for making sorties, the batteries must have covered communications to connect them, and cover for troops to support them; and in proportion to the force and facilities possessed by the garrison must these precautions be increased.

If the wall of the Fortress be not exposed to fire from a distance, the breaching battery must be established nearer; and when it has a revetted counterscarp, the approaches must be carried close to it, to enable a clear passage to be formed to the breach.

Certain outworks under different circumstances will demand similar works of Attack; and through the whole proceeding there must be covered approaches and assembling places, for the passage of the troops, and for the lodgement of sufficient number to protect the batteries from sorties.

From these data will be perceived the necessity for giving such a direction to the approaches, which are formed in zigzags, and to the parallels, as will secure them from enfilade; and these works will be more or less in proportion to these considerations, to the size of the Fortress, and strength of its garrison.

It is usual to lay down a system of Attack in three parallels, the first at about 600 yards distance, the second at 300, and the third on the glacis; but it should be borne in mind that this is only to give *an idea* of the mode of carrying out the general principle under ordinary circumstances, and not as a fixed rule; for the siege of a place garrisoned or supported by several thousands of men, in fact by a small army, with its environs exposed to its fire for a considerable distance, may require parallels and support from 800 to 1200 yards off, and to be much more numerous and irregular than the three defined parallels above described, for it would be impossible in that case to establish yourself at once so near as within 600 yards, while in proportion as the force of the place is reduced, the operations may be diminished down to the minimum of the single breaching battery.

It may be mentioned here, that a large place strongly garrisoned, however inferior the fortifications, is far more difficult to take than a small one, however complete and perfect its works.

There are many reasons why this should be the case.

1. It is difficult to conceive a case where such a place could be completely invested, on account of the great extent of encampment out of gun-shot round it; every part would be weak, and liable to be attacked by the concentrated force of such a garrison.

2. The space at the disposition of the garrison would be so large, that every part of it off immediate duty on the front of Attack, would be quiet and undisturbed.

3. The different fronts would approach nearer to straight lines, and their works probably not to be enfiladed; or if an angular or salient point be selected for Attack to give that advantage, that very salient would probably afford convenient position for strong and multiplied interior retrenchments.

4. Every sortie becomes a battle of armies; and any error in resisting one may lead to a great disaster.

5. Abundant supplies of Artillery and means can be drawn in succession, as required, from the many fronts not attacked.

6. Retrenchments may be formed in succession; for even trifling intrenchments

will be very efficient when on a small front, backed by strong forces, and perfectly secured in flank, where the assailants advance from confined trenches, subjected to heavy vertical and other fire.

On the known advantages which even a few slight works, on a tolerably good position in the field, will give to an army of very inferior force, it may be conceived how strong must be one protected by any thing of the character of permanent fortification.

Subject to the above-mentioned caution, we give plans of the regular system of Attack, as laid down by Vauban, and never altered since, as the best *illustration* of the nature of the principal operations.

On referring to recorded accounts of Sieges, it will be found, that against powerful garrisons, the besiegers have usually under-estimated the required works, and have experienced the necessity, as they proceeded, of obtaining more support, and at greater distances than at first intended: this error has very probably arisen from the impression left in the minds of the Engineers by the precise form and proportions given in Vauban's Diagram. An unnecessary amount of extra work will, from the same cause, (of adhering to fixed rule, instead of attending to principles,) have been frequently applied in the siege of small places; but the evil in that case will not be so apparent.

PRINCIPLES THAT MAY SERVE TO GUIDE THE DETERMINING OF THE FRONT FOR ATTACK.

As regards *natural causes:* the fronts of a Fortress are usually deemed *unattackable* by siege operations, when situated on steep rock exceeding 40 or 50 feet in height. Also those surrounded by water that cannot be drained off, or by marshes; or whose front is seen in flank and reverse by ground in inaccessible situations, having works on it which cannot be silenced; or generally in a re-entering angle.

The Attacks of Fronts are *very difficult,* when the approaches must be carried over rock or very stony ground, or among roots of trees, or in a very wet soil, particularly where the natural inclinations will not admit of a free drainage of the trenches.* Also when descending towards works that are on commanding elevations; or approaching them on a lower level, not being in the same plane; or when the approaches must be carried across a narrow confined space presenting a smaller front than that of the place.

As regards the nature of the works: the difficulties to the progress of the besiegers may be greatly increased when the works are countermined;—where the ground to be passed over may be inundated;—where the front is in one very extended straight line, or nearly so;—where the ditches are cut out of solid rock;—where the flanks have casemated guns;—the revetments en décharge;—with ditches that by means of sluices can be inundated and dried at pleasure;—or where there is a succession of lines of works, each requiring close breaching batteries;—or where the ground and buildings immediately within the front are very favourable for being made into strong retrenchments; for, generally speaking, the nearer the works of defence, whether permanent or temporary, are to the body of the place, the greater obstacles will they prove to the besiegers.

Circumstances favourable to the Attack, are of course the reverse of the above; also where the ground to be passed over presents much or occasional cover, either from its inclinations, or from artificial objects, as buildings, mounds, trees, enclosures, &c.

Ground rising gradually in one plane to the parapets of the works is favourable for the besieger.

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* Drainage of all parts of the trenches is very necessary, even in dry soils, to prevent the effects of rain alone.

It is advantageous to carry on Attacks along one bank of a river, where you have entire possession of the other bank, on which batteries can be placed to take the front of attack in enfilade or reverse, and particularly if that other bank is high and commanding.

Sometimes, a front that is not absolutely the weakest may be selected for the Attack, from some adventitious circumstances of advantage on other accounts, more than counterbalancing that consideration. As for instance, there may be peculiar facility for bringing up all the necessary supplies of artillery and siege stores on that side, by some navigation or favourable roads, or the army may be more advantageously circumstanced by that selection, for covering the operation and securing the communication with the dépôts from whence the supplies are drawn.

PREPARATIONS FOR OPENING THE TRENCHES.

1. Besides the collection of the regular Dépôt of Stores,* there are a vast number of materials to be provided in the country itself, and usually from the neighbourhood of the Fortress; they comprise

Platforms, Sleepers, and Planks.
Splinter-proof Timbers.
Trestles or other materials for Bridges of communication, large or small, &c.
Hand barrows.
Ballast baskets.
Fascines.
Gabions.
Pickets and Mallets, &c.

The greatest diligence must be used in collecting these in sufficient quantities, from the commencement of the investment; or earlier, if a navigation or other means of transport shall be available for bringing up such materials from a distance.

The following will shew the exertions necessary to be duly provided with such materials, with reference to such an Attack as is given in Plates I. II.

In the Attack of a Decagon, as given Plates I. and II., supposing ten days are allowed to prepare the following materials, as *about two-thirds* of the total quantity, before ground is broken, it will take 870 men per day, exclusive of Non-Commissioned Officers and contingencies; and not reckoning about 400 men employed at the same time in collecting brushwood for gabions and revetting fascines, or those on escort duty, with upwards of 100 carts and horses collected to transport these stores, or materials, to their respective destinations.

MATERIALS.

Trench fascines		5 ft. × 10 in. diam.	9,500
Revetting do.		18 ft. × 10 in. diam.	3,000
Sap gabions		2 ft. 9 in. × 1 ft. 8 in. ext. diam.	13,000
Battery do.		3 ft. × 2 ft. diam.	1,500
Platforms, gun and howitzer		18 ft. × 12 ft.	66
Ditto, mortar		8 ft. × 8 ft.	20†
Splinter-proofs	for magazines	10 ft. × 6 in. × 6 in.	1,000
Cap and ground sills	for magazines	15 ft. × 6 in. × 6 in.	100
Pickets (4-feet) for fascines			38,000
Fascine trestles			100

* During the progress of the siege, dépôts of materials, tools, and stores, are formed in different parts of the trenches, and are kept supplied with every article required, by the working parties, and sometimes Guards of the Trenches, whenever they come on duty.

† The entire number.

TOOLS.

Adzes	25	Pickaxes	15
Axes, felling	50	Saws, hand	160
,, broad	20	,, cross-cut	20
Bill-hooks	850	,, pit	15
Crow-bars	10	Spades	15
Fascine choakers	35		

With regard to Fascines and Gabions, it is impossible to over-estimate the great advantage of an ample supply.

A Sapper with gabions can cover himself from view and from musketry completely, in about 15 minutes; and partially from case-shot, in 30 minutes, in ordinary soil, after the gabions are placed.

With a fascine of 10 inches diameter he can obtain the same cover in 45 minutes; and without either he will require 50 minutes.

Independent of that advantage, the work is more easily and regularly executed, and the parapets in better form for defence, by the employment of these means.

It would be almost impossible to procure a supply equal to all the demands that would follow an adherence to the rules and drawings laid down for Sieges in elementary works.

There are many applications of fascines, particularly to the parallels, thus defined, that probably *never* have been used in an actual siege, such as the crowning of gabions with a triple, or even a single row, &c. Tracing fascines in a first parallel and approaches are, it is believed, seldom used, although certainly they are of advantage, and might, after a nearer parallel is established, be taken up, and the materials used again.

In a siege, the difficulties and losses will in a peculiar degree be increased with the length of time occupied in the actual operation; every effort therefore is made to proceed as rapidly as possible after the first commencement.

Hence it is better to delay the opening of the trenches till the preparations are in so forward a state as not to occasion any liability to subsequent delay for want of materials, or other means.

2. Before the opening of the trenches, the ground on which each part of the first night's work is to be executed must be *thoroughly* defined and understood.

The first course is to construct a plan, on which, by distant observation and measurement, every particular feature and object must be shewn in its true relative position.

Much inaccuracy will occur by trusting to the ordinary rough field sketching, by pacing and pickets, &c., &c.; therefore it is necessary that the particulars should be accurately defined by good surveying instruments, and Officers well experienced in the kind of operation, and who will be *responsible* for the work.

However well this may be done, and however minute the observations made from a distance on the guides to be afforded by particular objects and marks, they will not be sufficient to enable the Engineers and Sappers to lead, and place the covering and working parties in their proper positions on a dark night; and the consequence of trusting to them would be inevitable confusion, and many errors in the works.

In addition therefore to that knowledge, a most perfect acquaintance with the locality itself must be obtained, by effectual investigation of every part by the Engineers personally on the spot during preceding nights, and such marks even *fixed* as can be done without danger of their being discovered by the garrison.

For this object, as well as for many others that are very desirable, the garrison should

be kept close to its walls, (if possible, within them,) particularly by night, from the first investment.

There will be a struggle at first, and perhaps continuously, for the advantage of extending the outposts to the front by both parties, and if persevered in with energy, of which it is well worthy, will be resolved at length into that of absolute power, which will probably be, that a garrison of moderate strength may be kept very close to its works every night; and in the day, small parties and stragglers will be able to be out to from 300 to 600 yards from the place, if the environs for that and greater distances are well exposed to the fire from the fortress.

It is usual to attempt to deceive the garrison, or, at least, to leave it very doubtful as to the part that is meant to be attacked. If that can be done, it will be of advantage, but will require many additional precautions, such as making the same efforts and demonstrations throughout on other fronts that may be considered liable to be attacked: there could be no use in carrying on similar pretences against those that are clearly of very superior strength.

The last night before opening of the trenches, the most complete recognition of the ground to be traversed and occupied will take place by the Officers and Sappers who are actually to conduct and direct, and every mark placed that can be without risk of discovery, which, it must be recollected, may be made by any single enterprising individual from the garrison getting to the ground by stealth during the night or day.

3. There is a system and peculiar order to be observed by working parties in opening ground under the guns of a garrison, that requires to be understood by every man in the army, more particularly as they are performed in the night, and in perfect silence. Hence it is most desirable that every soldier should by corps be exercised in these different operations that he will be called on to execute.

1. In laying themselves out to ordinary trench-work, with and without fascines or gabions.
2. The system of work in batteries.
3. The nature and extent of the different tasks that will be considered the complement of one tour of duty in trench and battery-work for night or day.

It will not be necessary that the soldier should do much actual work in these exercises; many of them, none; but that they should become thoroughly acquainted with the forms of proceeding by good practice, and with what they will have to execute, by specimens shewn them.

They should also have such acquaintance with the amount of labour required for each defined task, by seeing a few Sappers execute them or otherwise, as may satisfy them that they are by no means hard, but can be readily performed by a little exertion.

Another good result may be derived from these exercises if conducted with due formality, in attaching more military effect to the duty than is usually now the case.

On this subject it may be useful to add a few remarks under the head of

MILITARY LABOUR.

It is a matter of some importance to ascertain and define the value of military labour, and the mode of applying it to the greatest advantage.

It may be affirmed that the services that may be rendered in a campaign by zealous and well-regulated work to be performed by the troops, is not sufficiently appreciated, nor sufficient pains taken to encourage and enforce it.

The ordinary day labour of soldiers is inferior to that of any other class of men; and there are many reasons to account for it.

1. Soldiers have no inducement to work hard; it is not to procure them a livelihood, nor have they any encouragement for exertion, nor punishment for indolence.

When set to work, it is not uncommon for a soldier to remark, that he enlisted because he did not like work.

2. Commanding Officers have a great dislike to their men being so employed, as it wears out their clothes, and is considered to tend to their being less well set up in the ranks.

3. Officers and men are apt to consider it as an extra and unprofessional duty.

It is very desirable that these feelings should be corrected, and that the army should become sensible of the advantages to be derived from laborious exertions with the pickaxe and shovel, as laid down in the Queen's Regulations, and but commonly little attended to.

Let an army once take the field well provided with Engineers and Sappers and a good dépôt of Intrenching Tools; let them never neglect, when near an enemy, to work at improving their communications, bridges, &c., strengthening outposts, and intrenching themselves with judgment in every position in which they can be attacked; and they will soon find the advantage it will give them in a day of action; so great, that a vast deal more stress will be laid on the system than is now attached to it.

If any Officer who has seen much service will recall to mind the days on which he has been engaged, and conceive the force which received the Attack, (whether his own or that of the enemy, but particularly his own,) with such redoubts and works and cover, as could with the means which will be found suggested under the heads Intrenching Tools, Stores, &c., have been thrown up even in twenty-four hours, he will at once perceive how far superior his situation would have been, and with how many more chances of success.*

From the commencement of the Duke of Wellington's campaigns in the Peninsula and Belgium, Vimiera—Talavera—Busaco—Fuentes d'Onor—Albuera—the Nive, and lastly, Waterloo, each have presented circumstances whereby the position of the British Army might have been greatly improved by a timely and judicious application of intrenchments, such as there was time for: many casualties have been saved, and success made more certain; besides the innumerable situations where such supports would have been of great value to outposts and detachments.

It would not be an uninteresting study to take the plans of each of the above positions, and project what might have been done to each with reasonable means at hand, by those who are in the habit of employing them.

The Lines of Lisbon afford a splendid instance of the use of intrenched positions.

A proof of the manner in which the principle will force itself into attention during continued campaigning may be drawn from the first military authority extant.

During the earliest campaigns in the Peninsula, the Engineer Department consisted of a few Officers and a very small detachment of the ill-organized Corps of Royal Military Artificers, without any intrenching tools or stores.

In 1811 and 1812, although there were far from a superabundant means of

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* History is full of examples in proof of this.

The gain of the decisive battle of Pultowa, in which Charles XII. was defeated for the first time by the Russians, was attributed to a few very imperfect redoubts, thrown up by the latter during the preceding night.

In the hard-fought battle of Borodino, in 1812, the redoubts are said to have occasioned immense loss to the assailants, although of so weak a profile that at last the French cavalry made its way into them.

transport with the army, 100 mules were allotted, by the Duke of Wellington's orders, to the conveyance of a small dépôt of intrenching tools and Engineers' stores. In 1813, a pontoon train was organized and added, and some companies of Sappers joined from England, but unfortunately not long before the Peace of 1814.

In 1815, with the army in France, companies of Sappers, and dépôts of intrenching tools, &c., on a much larger scale, were attached to each division of the army.

Notwithstanding this commanding testimony to the value of preparation for military labour in the field, and the importance attached to it by that paramount authority, there is every reason to believe that the same apathy with regard to the exertions to be used in such operations would still be found to continue in the Army, and cannot be too strongly deprecated. Whatever may be the sentiments or efforts as regards ordinary work, it is impossible to stir a step without it in a siege, or to evade the necessity for exertion then; still we can state from experience that in the Peninsula, the latest service we have of the kind in Europe, the amount of work executed in the trenches by given numbers of men in given times was very far less than what it might have been; and even that was performed in a listless manner: the working parties were handed over to the Engineers; their own Officers rarely interfering to promote the operation, unless in cases of a Sortie or Assault, when they would immediately resume their habitual energy.

It is the duty of the Engineer to arrange the men and tools, and to give every necessary direction and attention for the labour being properly applied; but the Regimental Officers should be entirely responsible for the quantity of work performed; and it should be held equally discreditable to a corps to be deficient in exertion in that branch, as in the neglect of any other duties.

*The result of experience shews that the spirit and efficiency with which any corps conducts itself on working parties, is no mean criterion of its general order and discipline.**

The consequence of want of exertion in work in the trenches is very serious, independent of the loss of time in the operation, when a day or two difference may lead to success or the reverse, and affect the whole campaign: a larger number of men are employed and exposed, and this severe duty comes oftener on the men; for it is manifest that if 500 men could by proper exertion do what you are obliged to bring 600 men for, 100 men are employed in the trenches throughout the siege more than necessary; and this is not an exaggerated proportion to allow for what has been the nature of performance in such duties.

A practice was very common which was very injurious to this service, and shews the injudicious view taken of it, namely, that of keeping the roster for it by detachment, and according to the precise strength of the regiments, and not by corps, as it should have been: the consequence was, that working parties of a few hundred men were composed of officers, non-commissioned officers, and men of various different regiments. It may be conceived how little order or discipline would be kept up in such cases, particularly by night, and how little these bodies could imagine it to be necessary: as a natural result, many of the men made no scruple of evading the work,

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* In a Siege, more than in any other service, there are opportunities for individual acts of intelligence, spirit, and exertion; and such acts may be of very great advantage, whereas in the Field they are only instances of a display of courage.

Hence it would be peculiarly desirable and politic at sieges to establish a system of rewards for such acts.

In the French Service it is quite usual to order a gratuity to the individual or party, of money, if consisting of Privates or Non-commissioned Officers: Commissioned Officers obtain promotion.

Perhaps medals might be a better reward than money.

which was done with impunity, and the rest worked very indolently. This practice should be abandoned, and all working parties furnished by corps, each with their own Officers, even although it may make a little inequality in the proportions according to their precise strength.

The most advantageous mode of applying soldiers to Field or Siege-work will be, where it is possible, by tasks; which will be described hereafter.

With reference to the labour of soldiers in the field in general,—there is one consideration that must not be forgotten in estimating the amount of work that may reasonably be demanded from them in given times, which is, that during the hardships, deprivations, and fatigues of a campaign, they have not by any means the physical powers of an ordinary labourer living at his own home. Their tasks should be calculated accordingly; but whatever it may be, it should be executed with alacrity and spirit.*

ARRANGEMENTS PECULIAR TO THE ENGINEER DEPARTMENT.

The whole of the Engineer department will encamp at or near the Dépôt.

The Ordnance Assistant-Commissary will have charge of the office and all stores, and will be responsible for their care and maintenance.

He will have to assist him, the Clerks and Conductors of Stores, and a small detachment of Sappers.

The tools and stores of all sorts will be kept in order and readiness to be delivered out at a moment's warning, during night or day, by the Sappers of his detachment on duty.

He will send a Sapper daily to the trenches, to collect all the broken and spare and dispersed tools, with the assistance of a few men from the working parties, which the Officer on duty will give him.

The broken tools will be immediately repaired by the Smiths and Carpenters employed for that purpose.

The fascines and gabions must be regularly piled, and not allowed to be removed except for the works.

The sand-bags will require particular attention, to prevent their being purloined for many purposes to which they can be applied; as will also the axes, hatchets, and bill-hooks.

If they should not have the advantage of any other protection, the stores and tools will be enclosed by a rope fixed to picketing posts, and no one allowed within it by the sentinel but parties having business there.

The Artificers, Fascine Makers, &c., must be responsible for the tools delivered to them, of which a record is to be made.

The Ordnance Commissary has charge of the workmen in the Dépôt.

His Clerks will enter regularly an account of receipt, issue, and expenditure of stores; of all persons attached to, and employed by, the Engineer department; and of their pay, either for day or task-work.

The workmen should be paid every evening.

The Carpenters are divided into numbered brigades of four in each.

The Sappers into brigades of eight.

The Miners into brigades of four.

As soon as parallels are entirely established, and safe from being carried by sorties,

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* It is very desirable to provide some regular organized means by which the different parties could always obtain *water*, without having to send numerous detachments out of the trenches, altogether with imperfect means, for bringing it in small quantities.

small dépôts are formed in them, where the Officers of Engineers will be able to send readily for any article required. A guard is placed over them, with at least one Sapper; and the platforms (among other things) may be collected there by degrees, brought in by the working parties, to be in readiness as soon as required, and from whence they will be less liable to be mixed than when brought at once from the main dépôt to the batteries.

The following will be the dimensions and prices* paid for the fascines and gabions, &c., brought in by the different parties.

The prices are calculated on the supposition that the parties find their own materials, where they are in plenty and near at hand.*

			ft.	in.
Large Sap Gabion, ready for stuffing, 6*s.* each.	Diameter (from centre to centre) of pickets		3	6
	Height of the wattling		5	0
	Distance asunder of the seventeen pickets		0	8
Common Gabion, 1*s.* each.	Diameter		2	0
	Height of the wattling		2	6
	Eight pickets or stakes	Length of each	3	0
		Diameter . from 1 to	0	1½
Battery Fascines. 18 feet, 2*s.* 6*d.* 12 feet, 1*s.* 10*d.* 9 feet, 1*s.* 5*d.*	Length		18	0
			12	0
			9	0
	Diameter 10 inches, or circumference		2	7
	Distance of the gads asunder		0	9
Fascines for stuffing the large Sap Gabion, having a Stake or Picket within each, 1*s.*	Length		5	0
	Circumference		2	0
Tracing Fascines (Fatigue work.)	Length		5	0
	Circumference		2	0
Fascine Pickets (Fatigue.)	Length not less than		3	0
	Circumference, at thick end, from 3 to		0	5
Gads (Fatigue.)	Length not less than		4	6
	Circumference, at thick end, from 3 to		0	5
Stakes for the Horses or Trestles for making Fascines on.	Length		5	0
	Circumference, about		0	10
Horses or Trestles all ready, the 6 for an 18-feet Fascine, 8*s.*	Distance asunder		2	6
Fascine Mallets, (of hard wood,) 1*s.* 6*d.*	Length of the head . 8 or		0	9
	Diameter of ditto . 5 or		0	6
	Length of the handle . from 3 to		5	0
Each Gun Platform,† 10*s.*	3 Sleepers.	Length of each	14	0
		Width	0	5
		Thickness	0	6
	1 Hurter.	Length	8	0
		Width	0	8
		Thickness	0	8
	14 Planks.	Length of each	10	0
		Width	1	0
		Thickness	0	2

* These prices will of course be liable to variation from localities: as given above, they are taken from memoranda of Peninsular Service.

† These platforms are of the lightest advisable description, and will weigh less than those given in the list, p. 71. Whatever changes may occur in the construction of platforms, &c., &c., the above, as the result of much experience, have been retained as valuable precedents, though they should be but partially applicable.—*Editors.*

				ft.	in.
Each 13 or heavy 10-inch Mortar Platform, 8*s*.	3 Sleepers.	Length		7	0
		Width		0	8
		Thickness		0	8
	11 Sleepers.*	Length		6	0
		Width		0	8
		Thickness		0	8
Each 8-inch Stone or other light Mortar Platforms, 7*s*.	12 Sleepers.	Length		8	0
		Width		0	6
		Thickness		0	6
Splinter-proof Timbers, for Magazines, 1*s*. 6*d*. each.		Length	from 9 to	12	0
		Width	from 4 to	0	10
		Thickness	from 6 to	0	10

Carpenters, for pointing, trimming, and cutting pickets to their proper length, may be allowed 1*s*. per 100, the pickets being brought in for them.

The Sappers and Men of the Line attached to the department are paid according to the Regulations.

The Fatigue parties from the Line for collecting materials in the rough and in bulk, and the ordinary working parties during the siege, are not paid.

The Serjeant of the Dépôt will receive these stores, and give an account regularly of the quantity delivered to the Clerk, to be entered in the books, as well as all issues.

All the articles which are not well made and nearly according to the prescribed dimensions will be rejected; for those accepted, a receipt will be given as they are brought in.

Gabions,† to be received, must be strong, stand firm, and upright, and the work close;—a few rows of wattling, well bound together by at least four gads at top and bottom; and in no part of their length or diameter varying more than 2 inches from the proper dimensions.

Battery Fascines,† to be accepted, must be straight and cylindrical, closely bound with good thick gads not more than 9 inches asunder, and the knots well tied and in a line; the length to be exact, and the thickness in no part to vary more than one inch from that prescribed.

DIRECTIONS TO THE OFFICERS OF ENGINEERS AND THEIR DISTRIBUTION.

The Second in Command will be Director of the Attacks. He will be obeyed by the Department in all parts, and must pay his particular attention to preserve regularity in the trenches, and more especially to the laying out of all new works.

The Brigade-Major and Adjutant will keep in order the Returns, Rosters, Official Letters, &c., and have particular charge of the Sappers: they will occasionally be able to visit the trenches to assist the Commanding Officer, or for his information.

A certain number of Officers will be divided into numbered Brigades of two in each.

The unattached Officers may be in the first instance employed in setting to work the Gabion and Fascine Makers, and the arranging the Platforms, or they may be put as supernumeraries to the Brigades.

A nominal list will be made out of the distribution of the Officers and Sappers.

The hours of relief will be 4 P.M.,—Midnight,—and 8 A.M. Or, 5 P.M.,—3 A.M.,—and 9 A.M., as found best, to which the Officers must make it a point to be punctual, particularly for the afternoon relief. There should be some means taken

* Used as planking; they were unnecessarily thick.

† Vide 'Gabion,'—'Fascine.'

of fixing the time by signal or otherwise, once in each twenty-four hours, for the whole encampment.

The Officers of Engineers must pay particular attention to the different directions for carrying on the works, which will be given out by the Commanding Engineer. They will recollect that the main object in a Siege, where the new work is generally commenced at night, is *arrangement;* upon that point too great a stress cannot be laid; they must therefore use their utmost exertions to preserve regularity and system in all the operations. It is better to delay half an hour, or even an hour, in commencing work, rather than begin in confusion; they must call upon the Officers of the working parties to enforce their directions, and to encourage the greatest exertions on the part of the workmen.

The Commanding Engineers' daily order, given at 2 P. M., will make every one acquainted with the works to be executed during the ensuing twenty-four hours. The Officers must cause their Sappers to see every article they will require prepared in time; that is, tools or stores laid out, and tracing lines, measuring rods, &c., prepared, and the Senior Officer of each Brigade will order the arrangement of his party.

They will report particularly in writing to the Commanding Engineer the good conduct of any of the Sappers and Miners, as well as any instance, if such should occur, of misconduct of any kind, or of want of spirit, exertion, or ability.

The Senior Officer of each Brigade will, on his return from duty, send in to the Office a written account of the extent of work performed, with remarks on the conduct of the working parties and of the corps they were furnished by, as well as a detail of the occurrences of his relief; such as, of Sorties, of the nature of the fire from the enemy, and of our own, with their apparent effects; the works the enemy may be carrying on, as well as he can perceive, &c. These Reports, revised by the Director, will be copied into a book or journal, kept at the Royal Engineers' Office for that purpose by the Adjutant.

They will give certificates in writing to the parties for all task-work; for which purpose they will find it convenient to go prepared with every thing written on small slips of paper, but the quantity of work, which can be filled in on the spot. For the Sap, and such works, the payment will be made on these certificates.

OPENING THE TRENCHES AND FIRST PARALLEL.

It is usual to undertake, on the first night of opening the Trenches, the entire of the First Parallel, or protective position, and its approaches.

We will assume in this case that this Parallel is to be at about 600 yards from the salient angles of the covert-way, with two or three approaches, as shewn in Plate I.

The 600 yards distance for the First Parallel is from the main works of the place, without regard to any detached works, unless they are large; it is considered in ordinary cases the best, because beyond the effect of much injury from grape shot or musketry, or of any serious sorties from a garrison of moderate strength; and because it is about the extreme distance for very steady howitzer practice.

The Parallel is extended in length 50 or 60 yards beyond the prolongation of the extreme faces of the works of the front to be attacked, and turned round at the ends as a protection to each flank, or should be finished by a redoubt or palisading, where there is much to apprehend from sorties, if the garrison is strong. See Plate I.

The approaches in zigzags should be directed to a point at least 30 yards outside of the extreme parapet or covered way of the garrison from whence fire could be directed on them, in order to avoid effectively not only enfilade but ricochet shot.

In section the parallels are 10 feet wide, including the front banquette, and the

approaches 8 feet without a banquette: each of them have an average depth of 3 feet, with a slight fall from front to rear for drainage, and which also affords some advantage in defilading the trench, or improving its cover.* Plate I. figs. 2, 3, 4.

Means for getting easily out of parallel and approach to oppose sorties, particularly from the former, should be afforded.

The interior slope and top of the parapet of the parallel is shaped with the shovel, so as to give the most cover with a proper height (4 feet 2 inches) to fire over.

In great Sieges the width of the parallel will require to be increased, and in very small ones may be reduced.

The approaches forming the roadways into the trenches could hardly be reduced under any circumstances; and those of the first entrance, that is, up to the first parallel, will probably be better of greater width, to give more freedom of passage.

It will be an object to endeavour to conceal from the garrison the *time* of the opening of the trenches, because if the first night's work can be executed without interruption, the operation will be much facilitated, and many casualties saved.

This is to be done by keeping the assembling of the troops for the purpose, and other demonstrations, as little perceptible as possible.

The Covering† and Working parties will be given from the nearest encampment; the latter will assemble in due time at the Engineers' Dépôt, where the tools and materials will have been laid out in readiness for them.

To preserve ordinary appearances, the Pickets usually employed to confine the garrison to their works will proceed in their accustomed manner and time: they will form part of the covering party for the night.

Immediately after the darkness of the night is sufficiently complete to *insure* the impossibility of observation from the enemy, the Engineers, aided by their Sappers, proceed to mark out, as rapidly as they can, the lines of parallel and approaches.

No saving of time, however, is to justify any degree of inaccuracy; they will therefore have considered deeply, and by as many actual trials as possible, in recognizing and fixing the localities, how to secure the accomplishment of this duty with accuracy and rapidity.

As soon as the necessary given points shall be found, the especial Covering party for the protection of the work will be led out to their positions by Officers of Engineers.

The main bodies will be posted in line about 100 yards in rear of the parallel that is to be formed, and in the intervals and on the flanks of the approaches.

If any part of it can be placed under cover of rising ground, buildings, &c., advantage will be taken of the circumstance.

Strong advanced Guards are detached to about 100 yards in front of the parallel; they will remain collected in small parties; posting in their front again, a line of Pickets near enough to prevent any one passing between them unobserved.

To prevent mistakes and false alarms, the working parties must be made acquainted with the circumstance of a portion of the covering parties being in their front.

In laying out the lines, the principal points are first marked with pickets made visible by bunches of straw, or white paper, about their heads; and the intervals

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* The rear of the trench is much the most exposed to the fire from the garrison: although not exposed to view, many casualties happen there from shot dropping in immediately over or through the top of the loose earth parapet.

† The protective force has usually been denominated in the British Service "*the covering party*," which may be correct previous to the construction of any of the trenches; but subsequently "*guard of the trenches*" would seem to be more appropriate, and is more in accordance with the practice of other nations.

defined by straight lines of white tape,* which is to denote the actual line of the excavation.

Each man of the working party carries a pickaxe and shovel, and a tracing fascine (if the latter be employed); the fascine on the shoulder that will be towards the enemy as he files into his position to work.

When the lines for the works are sufficiently marked out, the Brigades of Engineers, with their Sappers, lead out the working parties direct to the several points from whence each is to be arranged.

When the head of the file reaches the fixed point from whence that party is to commence, he is halted, and his fascine taken by a Sapper and laid parallel to the white line, and at 18 inches from it; the next man files up, and the same is done with regard to his fascine, and so on till the whole are placed, every man in succession sitting down on his fascine, which thus marks the length of trench allotted to each.

There must be no wavering, or chance incurred of misleading covering or working parties to their precise points in the nearest direction, and by that which is most clear of obstructions: if at all necessary, men with dark lanthorns will be fixed at particular points, essential for obtaining the proper direction.

Lanthorns for this purpose may be fixed or hung on a disc of tin or wood, to form a screen on the side of the garrison, and must only be entrusted to a N. C. Officer of Sappers, or some man who can be thoroughly depended upon for steadiness and intelligence, to prevent it being observed by the enemy. The light should be small, and not be allowed to strike on any *near* object.

When the *whole* are placed by *all* the Brigades, and not till then, the word is passed, or some signal given, (that cannot be perceived by the garrison,) to commence work, which is then to be pushed on vigorously; but, if still undiscovered by the enemy, with as little noise as possible.

Should no tracing fascines be employed, the proceeding is carried on in the same form; but other means must be adopted for placing the men at a proper distance asunder.

The first night's work is necessarily a short one: suppose the excavation actually to commence at nine or ten o'clock of a summer's night,† there will be probably five or six hours available in the dark, and about three more after dawn.

It is usual to anticipate but a small portion of work to be executed on this first night; each workman having 5 feet of length of trench, and the given depth of 3 feet to excavate, only 4 feet in width is the quantity laid down as reasonable to expect, being less than 2¼ cubic yards. This should be considered the very minimum, even in unfavourable soils, (not being rock or swamp,) or the weather particularly bad, or the party under serious interruption from the enemy: it is a very trifling amount of work for a man to execute, and half of it will be done by him voluntarily within the first hour, in order to gain cover;—so small a result, leads to the space obtained being most confined, and inconvenient to contain the guard as well as the workmen in the morning, besides that many other advantages would arise from greater energy in the first night's work.

Indeed, it is on record that the excavation for parallel and approach is frequently completed during the first night, leaving only the shaping and putting banquettes for the next party.

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* In Foreign Services a light-coloured rope is usually employed; white tape, or long strips of linen, however, of from 1 to 2 inches broad, as used in our Service, is particularly conspicuous in the dark, very portable, easily procured and managed, may be occasionally saved, washed, and used again, and considered altogether preferable.

† Latitude 38°.

In reference to Siege and Field-works, the quality of the soil is sometimes divided into three classes.

1. Light, and to be worked by the spade and shovel alone.
2. Requiring one pickaxe to two shovels.
3. Requiring one pickaxe to each shovel, which may be deemed the hardest, not including rock or large boulder stones.

The third case, consequently, would require double the number of men to execute any given quantity of trench-work that the first would; or at given distances asunder the men would do half the amount of excavation.

A man working by day for ten hours could excavate in the light soil, and throw out earth with the shovel in such a trench, to the amount of about 10 or 12 cubic yards.

A *complete parallel* 10 feet wide by 3 deep, at the length of 5 feet per man, would be less than half that quantity, that is, little exceeding $5\frac{1}{2}$ cubic yards, and should be done with tolerable ease in light soil during the first night; or, in more difficult soils requiring occasional use of pickaxe, 8 feet in width (under $4\frac{1}{2}$ cubic yards) might be completed.

Either of these quantities, therefore, according to circumstances, might be expected for the first night's work, except in peculiar cases of difficulty.

During the night, and particularly just before clear daylight, the men must clear away the upper step of the banquette or berm of 18 inches in front of the excavated line, and lower the top of the parapet, throwing the stuff in both cases well to the front, in order to leave space for the earth subsequently to be excavated, without the necessity in the day of exposing the workmen to the enemy's fire.

All these arrangements will be much easier, and the entire operation more readily and cheerfully performed, if the whole of the troops understand thoroughly, by previous practice, what is required, and what is its utility.

Besides the precise number of workmen calculated to fill up the entire space, there is always added a good reserve (about $\frac{1}{20}$) to allow for any deficiencies when laid out, and for casualties, &c.; and even should that reserve not suffice, the General Officer commanding in the trenches orders out what may be necessary from the pickets, in reserve, in camp.

The working parties are laid out from the front, that is, along the parallel first, and thence to the rear along the approaches; so that any deficiency may affect the rear and part most distant from the enemy, where it is easier to be provided for.

It must be expected that there will be various spots and places to cross that will present more difficulty and require more skill to complete than the rest.

1. Water-courses and drains: these must not be interrupted, and will require pipes or openings made up of planking or other means to leave a free passage; otherwise, it will be necessary to open them subsequently with much labour and difficulty.
2. Hard roadways, perhaps paved.
3. Buildings, walls, ditches, shrubberies or trees, &c., &c., &c.

To all such places a few Sappers, or of the regular men attached to them, should be appointed, who will be properly provided with means, and will understand how to complete the line over such obstacles. Where the entire of the soil is of rock or bad swamp, it may be deemed impracticable to carry on siege operations over it, in front of a garrison of any power. Such ground may be passed, and even batteries constructed on it,* by the necessary extra earth or materials brought from the nearest or

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* A foundation of two crossed courses of fascines will support any work on any swamp.—*Editors.*

most convenient place, if that part of the operation be of small extent; to assist, the trench may be widened when depth cannot be obtained.

The General to command in the trenches, and the Guard, take the duty for twenty-four hours, and are relieved at mid-day; the Guard being furnished by battalions, if not by brigades.

The working party take the duty for twelve hours, and are relieved usually at 6 A.M. and 6 P.M.; the duty should be by companies at least, but better by regiments: in neither case by mere mixed detachments. If the besieging force be strong enough in proportion to the siege-work to be executed, a more frequent relief of working parties would tend to the more rapid completion of the work; but the arrangements should be such as to give the troops at least three periods out of the trenches, for one in.

The Engineers, Sappers, and men attached, should have three reliefs in the twenty-four hours, and at different periods from the working parties; and they will be well off if they are in sufficient number to have not more than one in four tours in the trenches.

When working parties are tasked, they should be dismissed scrupulously as soon as the task is completed; and more work will be obtained, and with more alacrity and satisfaction to the men by this mode, than by keeping them lingering over the work for twelve hours. There is also a great advantage in getting the work clear of these men for some time before the new party comes in; such interval is most usefully employed by the Sappers and their assistants in arranging the tools and work, and adjusting or completing any part that may be a little irregular, deficient, or exposed: this is so desirable, that when the men work even *by time*, it is well to collect and retire them a full half-hour before the arrival of the new party.

If the working parties have their arms, and form part of the strength of the force for resisting sorties, they must not be dismissed *from the trenches altogether* till relieved, but will be in that case only withdrawn from the work.

In cases of reliefs, or generally of parties meeting on any account in the trenches, the out-going party invariably halts, and lets the in-coming pass.

Should the opening of the trenches be decidedly discovered even early in the evening, and a heavy fire directed upon it, it can still be forced on by discipline and spirit, and without so much loss as might be expected.

The same precautions must still be taken by the Engineers to insure correct positions and lines, and in bringing the parties up. The only difference in the arrangements will be, that under such fire the workmen commence, each man as soon as placed, in order that he may be sooner under cover.

The result of such a night, however, will be some inaccuracies, and some parts imperfectly completed;—reserves will then come more particularly into service, and there will be more need for the adjustments applied by the Sappers and assistants.

In order to reduce the amount of duty, and the number of men in the trenches, it is the general custom now to make the working parties take their arms and accoutrements,* so as to make up with the guard the necessary number to resist sorties. It is attended, however, with many inconveniences. The arms and accoutrements are a great incumbrance to them, and being laid on the reverse of the trench, are liable to be injured;—in case of a sortie or alarm it is not easy to get these men collected and in order; they become mixed with the guard, and hence arises confusion; nor are they easily brought back to the work.

At all events, however, it is particularly desirable that the parties who first break

* Their knapsacks are left in camp.

ground should not take their arms: they have each two intrenching tools, and perhaps a fascine to carry; particular system and exertions are required from them; and it is unusual at that period to be opposed by any great sortie.

It would be less inconvenient for the morning relief to be armed, as they will have few, if any, tools or stores to carry; they can also take better care of their arms, and may be more likely to want them during the ensuing day.

SORTIES.

In ordinary Sieges, Sorties in much force, made upon the approaches when not less than 250 yards distant,—that is, up to the second parallel and its batteries, or farther, —can seldom be very injurious to besiegers, unless the latter are guilty of great neglect or want of caution, or have very imperfect means of protecting themselves.

The garrison in making a sortie has one advantage, namely, the shortness of the distance to be passed between the first alarm, and being in contact with the enemy; so that if the besiegers are negligent, it partakes of a surprise; but that advantage is to be neutralized by the troops in the trenches being taught always to expect such an attack at any moment, and the measures to be adopted being thoroughly understood.

After the French had made one or two sorties at St. Sebastian's with some success on a parallel at about 200 yards distance, the Guard in the exposed part of it were made during the night to sit on the reverse of the trench with their arms in their hands, in expectation of the next, and under instructions to charge the enemy the instant they should be seen on the parapet. This accordingly took place, and it was driven in at once without an attempt at a struggle, and was the last attempt of the kind.

The Sortie is also considered to have an advantage in being covered by the fire from the place; but if it be advanced to any distance from the works, it will probably suffer more loss in retiring to them, than the besiegers will from the artillery of the garrison.

The disadvantages of the troops making the Sortie are—

1. That they necessarily attack a superior force, probably very superior: the ordinary rule is, that the Guard of the trenches should be equal to three-fourths of the Garrison; it is seldom, if ever, that a sortie will be of any thing like that proportion, and the far greater number of comparatively small force.

2. That they are under the moral impression that definitively they will be forced to retire; and the only question being *when* that is to take place, they must be inclined to yield to the first spirited attack made on them.

3. In retiring, which it must come to, and necessarily in some confusion, the exposure and consequent loss must be heavy.

4. Every loss to the garrison is irreparable; whereas the supply for the trenches is, as it were, inexhaustible; in other words, the advantage would be with the besiegers in the loss of man for man with the garrison.

It would of course be of vast importance to the garrison if by sortie it could obtain possession, even for a short period, of any of the armed batteries of the attack; but such an advantage is not to be anticipated, unless occasionally, perhaps, in sieges of very large places.

The principal efforts are made upon unfinished portions of work, and the success will be more likely to be effective, if such unfinished part is extensive, and consequently farther removed from support.

A very short possession of parts of the trenches, lined with gabions, may cause much trouble, time, and casualties to the besiegers: the gabions being overturned into the trench and partially cut, are extremely difficult of removal, thus adding

greatly to the slow process of the Sap, or gradual progress made generally in the near approaches.

The disposition of the Covering Party on the breaking ground for the First Parallel is as follows:

The main body is drawn up in distinct lines, between and on the flanks of the approaches, and about 100 yards in rear of the parallel, detaching strong advances to about 100 yards in front of it, which also remain in compact bodies, excepting a close line of Pickets or Sentries, another 100 yards more in front.

These Pickets must be throughout on the sharpest alert, with their arms always in hand, frequently applying their ear to the ground, in order to be early aware of any movement of the enemy towards them.

If a single man or two should approach to reconnoitre, (which is very usual,) they must allow him or them to pass, and endeavour to make them prisoners without creating an alarm.

The advanced Guards will be always ready and in order to attack any sortie at once; and will probably repel it, unless very strong in force, which is hardly to be expected at that period.

The main bodies in reserve must remain collected and near their arms, and not ranging from the order in which they are to fall in: this may be deemed a general rule for night or day, and at all periods of the siege.

The whole (except the Pickets, who are usually on one knee, or reclining in a position for readily springing into action,) lie down, and if there should be much fire from the garrison, will have to continue so during the time it lasts.

As the day begins to dawn, the covering party takes its post in the parallel.

The construction of the Second Parallel is covered in a similar manner.

Sorties should be always opposed by a brisk advance with the bayonet, and not, even when the parallels are completed and by day, by dispersing the Guard along their parapets. The only men habitually on the banquette are the necessary Sentries to give timely notice of the approach of an enemy. Any other portion that it may be thought right to place at the parapet for receiving the advance by a fire from thence, should be told off and instructed for the purpose; but the greater proportion should remain collected in reserve for a charge. Firing parties are sometimes posted in the advanced works, to act against the defences, and would bring their fire to bear of course against a sortie in their front, although not the primary object for which placed.

Every attempt will be made, by position and movement, to act upon the flanks of the force making the sortie: if it is obstinate, and considerably advanced, it may be thus perhaps more or less cut off; at all events, it will be more speedily made to withdraw, and probably with more loss.

If the trenches are near, no sortie of much force can well be made, except by advancing from the sides collateral to those of the attack; in which case their own flank must be presented to batteries and works in rear, prepared for that purpose.

It will be an object of care and caution not to allow the Guard to follow too far, or to remain out longer than necessary; otherwise it may sustain great and unnecessary loss from the fire of the garrison.

It is much more difficult to regulate the proceedings of the working parties in cases of sortie, than of the guard.

Sorties are sometimes made (particularly by night) exclusively to create alarm and confusion, which must be met by firmness and judgment.

The working parties will in all cases rally and form behind the reserves of the Guard.

If they have not their arms, they will take care to carry away their tools with them;—

if armed, that is not to be expected: in the latter case they form as a second reserve to the Guard in the first instance, and are brought forward into action in support of it, if necessary.

In either case they are brought back to their work immediately the ground is cleared of the enemy; and it is a great effort of discipline that this should be done completely and with alacrity.

On night works, to prevent confusion and mistakes, the working party must always be made to understand thoroughly when there is any portion of the Guard in their front.

Commanding Officers of the Guards of the trenches should make themselves well acquainted with the position and nature of the works and approaches, making every arrangement for the system to be adopted for their complete protection.

During the construction of the Third Parallel and the works beyond it, many circumstances may contribute to render sorties more formidable or troublesome.

1. A garrison strong in force or in energy.
2. Inefficiency of means for reducing the fire of the place; or for preventing a freedom of collecting and manœuvring bodies of men within the front of attack, particularly in the covert-way.
3. The temporary reduction or interruption of the enfilade, ricochet, or other fire, against the works of the place, by reason of the new approaches, masking the batteries previously established, while those operations shall not be sufficiently advanced to be armed with Artillery means.

In such cases, small bodies from the covert-way may make frequent assaults upon the heads of the Sap, disable the Sappers and workmen immediately in their rear, and in a few minutes can materially injure the unfinished end of the work; for it will be perceived that the Guard of the Sap has no position where it *can* be collected in mass to receive such an attack; on the contrary, it is itself necessarily attacked in flank, and the assailants are very speedily back in their covert-way.

To meet such a system will require a great deal of steadiness and determination. The advanced portion of the Guard must be disposed as compactly as possible, and under precise instructions to be always in readiness, and to charge at once in the most vigorous manner.

Much will depend upon the first two or three efforts: if they are repulsed briskly, and with loss, such attacks will not be frequently repeated; if otherwise, and they meet with a degree of success, a moral effect will be ~~established~~ produced on both sides, that will tend very much to retard and disorganize the siege operations.

If the garrison shew a disposition to use these vigorous exertions, it may be necessary to run out Demi-parallels, (Plate I.,) or portions projecting from different angles of the zigzag approaches for lodging, supporting bodies of the Guard, near and in favourable positions.

Steps to the parapets, to enable the Guard to meet or attack the sorties outside of the parallels, will also be more frequent, and made with more care. (Fig. 3, Plate II.)

In the matter of opposing Sorties, as well as in the operations of working parties, previous practice and exercise would be of the greatest service; Officers and men would not be at a loss, but would then understand how to improve every circumstance.

POSITION OF THE BATTERIES.

The first Batteries constructed being those for reducing the fire of the place, are usually placed about 50 yards in front of the first parallel; if for Enfilade, one gun is to be close within the prolongation of the interior line of the parapet of the face, flank, or covert-way, to be enfiladed; and the remainder on the prolongation of the

rampart of the same. Each of these batteries must have its covered approach from the parallel, and its expense magazines.

They are usually commenced on the night succeeding that of establishing the parallel, and will require great care in being laid out in the proper direction, to produce the proper effect, which in works well defiladed is not always an easy operation.

Should the nature of the works of attack and of the ground admit of these batteries being applicable and efficient until the very near approaches, instead of its being required to establish others in front of the second parallel, it will be very advantageous.

1. Because the work is earlier, and more easily executed.
2. The batteries more easily supplied with ammunition and every necessary.
3. The distance is a favourable one for the purpose.
4. The Gunners less liable to casualties.
5. The batteries more retired, and consequently more secure from sorties.

From the period of occupation of the first parallel, every opportunity is taken by night or day of pushing on the zigzag approaches towards the next.

The principal requisites of these zigzags are—

1. To be quite clear from exposure to any degree of enfilade fire from the fortress.
2. To be confined between converging lines, that will not mask the fire of the batteries in their rear.

They are directed on the line of the capital of the work which they are approaching; and the converging lines, above referred to, will be comprehended between the salient angle of the work, and points on the first parallel, about 70 yards on each side of the prolongation of the capital.

SECOND PARALLEL.

The Second Parallel, under ordinary circumstances, is constructed at about 300 yards from the covert-way, and is opened under similar arrangements as described for the first, for even at that distance, its establishment can be enforced without much loss; but as the fire of the garrison is more effective, it is desirable to use gabions for it, if possible, and the workmen usually begin to cover themselves as soon as each is respectively placed.

The approaches from the works in the rear must be undertaken simultaneously.

Should batteries against the defences be necessarily attached to the second parallel, they will be also about 50 yards in front of it, and as described for those in rear.

It may be observed, that in general, in proportion as the works of Attack become nearer, the attention of the garrison is so much called to them, that, added to the effect of the fire on the defences, great liberties can be taken in the rear; thus, when the besiegers are on the glacis, little or no notice will be taken of any ordinary proceedings about the first or second parallel, or their approaches.

As the works advance, some means will be required to keep in order and repair the earlier works, but they will be small; their thorough drainage should be always attended to.

ON THE MEANS OF REDUCING THE DEFENCES OR FIRE OF THE PLACE.

The works of Attack cannot be carried on nearer than 200 yards of a fortress or fort of the least consideration, unless means are employed to keep down or greatly reduce its fire.

Nor can the storm of a breach, on which a flanking fire can be brought, be attempted without great risk of failure, and almost certainty of very heavy loss.

Hence the cause for reducing these means of defence; and it is well to advert to

these principles, because where the necessity does not exist, the formality of the operation may be dispensed with.

There was a striking instance of this in the siege of Ciudad Rodrigo, in January, 1812.

The part of the fortress attacked consisted of a revetted line of ramparts, surrounded by a revetted fausse braie, with a ditch and very low counterscarp, the whole unflanked, and the two escarps seen nearly to the foot, from a height within 500 and 600 yards distance.

The time that could be given to the siege, before a relieving army might be brought to raise it, was short.

The project was accordingly to effect a practicable breach by a powerful Artillery from the height, and then to storm at once, without approaching step by step in the more ordinary manner.

Twenty-six* 24-pounders were accordingly placed in battery for the purpose, and proceeded unremittingly in the work of breaching, *without paying any attention to the fire of the place*, which had a good garrison, and was well provided with Artillery.

The French Engineers remarked upon the singularity of this proceeding, but it was founded on good principles.

The fire of the garrison could not check the operation of breaching.

It was not the intention to carry the works of Attack very near the place; although during the operation, a small parallel was, with exertion and some difficulty, constructed on a lower intervening height, to within about 200 yards, *and the breaches were not flanked;* consequently, according to the project adopted, there was no absolute necessity for opposing the fire of the place; and any means applied to it would have been a reduction of those for the more urgent object of breaching.

The above is a very rare case, arising from defective fortification and the pressure for time.

Under all ordinary circumstances of sieges, it is necessary to pay great attention to the reduction of the fire of the place; and, generally speaking, the result of a siege operation, as regards certainty of success, amount of loss sustained, and time engaged in the undertaking, will be dependent upon the efficiency of the means employed for this purpose. If they are abundant, and skilfully managed, the Engineers' progress will be rapid and easy, by day as well as by night; but it may be understood how effective the fire of the besiegers ought to be, when it is brought to mind, that *the fire of the lightest piece of artillery on the head of a Sap will effectually stop its progress during daylight.*

The means employed for reducing the fire of the place are—

1. Enfilading the several lines of rampart and covert-way from guns or mortars.
2. Ricochet combined with enfilade.
3. Direct fire of artillery to ruin the parapets.
4. Musketry brought to bear upon the embrasures.
5. Pierriers, or stone mortars, and royal, as well as Coehorn mortars ($5\frac{1}{2}$ and $4\frac{2}{5}$ inches), when very near.

1. *Enfilade.*

A line subject to be enfiladed by guns at full charges, within moderate range, cannot be deemed tenable; hence one of the earliest improvements in fortification was

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* The number varied from twenty-three 24-pounders and two 18-pounders, to thirty 24-pounders and two 18-pounders.—*Editors.*

to construct the works so as to be *defiladed*, that is, so arranged as that their interior should not be seen: thus they were protected from shot, until Vauban invented the mode of effecting the object by ricochet.

No protection was afforded, however, against the effects of enfilade from mortars, either then or subsequently by the traverses, which were contrived to check the ricochet.

The enfilade by mortars against uncovered batteries is very destructive.

Where fronts are well covered, an enfilading battery is constructed against each face, or flank, &c., requiring to be silenced.

Circumstances seldom admit of the whole front being so enveloped by the trenches as to admit of enfilading it generally; but sometimes they are so, and a considerable advantage thereby afforded.

Such a position commonly occurs from the opposite bank of a river to that on which the place is situated, where batteries are constructed to take the entire front generally by enfilade; and many of its lines, consequently, at different angles in reverse.

If not only this advantage of position can be gained, but that they can be placed upon heights from whence the interior of the works can be *seen*, although even at very long ranges, such as 1200 or 1500 yards, as at St. Sebastian's in Spain, the advantage is very greatly increased.

2. *Ricochet*

Is a very formidable application of Artillery against uncovered lines. Even traverses afford but an imperfect protection against it. The shot ruin their interior angles, and the explosions of the shells in them act as so many mines of destruction; and as they are directed in enfilade, there are few of either but what take effect.

Ricochet practice, however, is one of perhaps the greatest nicety in the Service of Artillery, and cannot be too much practised: it is the more difficult to regulate with precision, as the actual course of the shot or shell in striking the object can scarcely be perceived, and requires a combination of accurate direction, elevation, and charge of powder, that can only be worked efficiently by well-exercised Gunners.

3. *Direct Fire of Artillery to ruin the Parapets.*

By the end of a siege, the parapets on the confined portion of the front subject to the last efforts, will be quite ruined by the direct and enfilading fire of shot and shells. For this direct fire, the nearer the batteries shall be to the place the better.

When direct fire alone is employed against the guns and defences of the fortress, they will never be entirely reduced, except in small confined positions, such as a single flank, and by a powerful and constant fire on it from a very short distance.

4. *Musketry.*

Where severe and well-directed musketry fire can be brought to bear on the embrasures of a fortress, from distances not exceeding from 200 to 300 yards, the fire of the guns has been frequently greatly kept under, and even silenced.

In some of the sieges by the French in Spain, the fortresses being of old construction, without salient outworks, Riflemen, Light Troops, or men of the Line acting as such, were frequently dispersed at some distance in front of the parallels, in small pits dug by themselves, and by their fire kept down the Artillery of the place sufficiently to enable the approaches to be carried very close, without employing Artillery (of which there was a great deficiency) against the defences.

This is a subject of boast, and a fair one, of the French Engineers.

Although musketry fire has been frequently so effective, and may be so again, it can hardly be relied on with any certainty, as it would appear that many expedients might be used to screen the Gunners from its effect, while the guns are at the same time actively served. If they had even a sheet of linen before the embrasures, so as to conceal the guns from view, there must be an enormous expenditure of ammunition to keep them constantly from being served. (*Vide* 'Battery,' Plate II. fig. 6, where a hanging mantlet to an embrasure is given.) The troops employed for firing parties in the trenches are usually protected from the musketry of the garrison by sand-bag loopholes along the parapets.

There is usually a very great expenditure of musket ammunition at a siege; in some cases there may be ready means for the supply, but in others there may not, and at all events, *waste*, which it frequently amounts to, is improper.

When parties are required to keep down the fire of the place, it should not be by posting them in large number indiscriminately in any situation, to fire at random; but by an adequate number of steady selected men, if possible good shots, placed in the most advanced and favourable points, covered by loopholes of sand-bags, fascines, &c., and never firing but with a precise object and steady aim: after loading they frequently leave the musket pointed, and watch for the next favourable opportunity to fire.

A small quantity of ammunition employed in this way will have a great effect, cause many losses to the enemy, and very much reduce his fire.

5. *Pierriers or Stone Mortars and Coehorns, &c.*

Pierriers are noticed in all works on Attack as an accessory; but there may be some doubt as to any effect being produced from them commensurate with the means required for their carriage, their service, and the narrow limits in which they can be placed; nor will the proper materials for supplying them be easy to procure in many localities.

Small mortars, such as the $5\frac{1}{2}$ and $4\frac{2}{5}$ inches,* are certainly very useful, particularly if employed in considerable numbers; they are very easy of carriage, easy to supply, and can be placed any where: their shells, poured into confined spaces, such as the outworks of fortresses, must be very powerful in preventing any strong occupation or demonstration from the work.

As above remarked, every thing that is to lead to a rapid and successful progress of a siege will depend upon the adequacy of the means employed for reducing the defences, and the energy and skill with which they shall be used.

Where they are well and efficiently applied, it is easy to conceive the state of the works comprehended within the front of Attack, ploughed up incessantly and in every direction by shot and shell,—not a place from whence a view can scarcely be taken from the parapet with impunity,—the moral effect on the troops must be depressing, on proceeding to do duty in such a scene, from the comparative quiet and security of the rest of the garrison; considering that it is not for the fair equal combat, which never fails to arouse the energies of the soldier, but to witness a gradual and discouraging diminution of their resources and hopes.

Even among the Officers and Commanders it will require men of peculiar energy to use very active exertions to see that every possible means of prolonging the

* In 'Artillery,' Colonel Lewis suggests the introduction of $6\frac{1}{3}$ brass mortars, (now that the 32-pounder howitzer is established,) as superior to the $5\frac{1}{2}$ and $4\frac{2}{5}$ mortar, though still of a size to be conveniently portable.

defence be employed in every part. Any weakness or neglect on the part of the Officer in command of even a small outwork may be very injurious to the defence.

THIRD PARALLEL.

After the Second Parallel, that is, within 300 yards, if exposed to a heavy fire, including grape and musketry from the garrison, the progress of the trenches can no longer be *forced* by extensive simultaneous breaking of ground; it is then regulated according to the degree of opposition made: whenever the garrison is inactive, immediate advantage is taken of it, particularly by night, to lay out more or less extended lines of gabions, and to set workmen to fill them at every opportunity: in this manner, especially at from 100 to 300 yards, the work is much accelerated.

While the fire of the place is animated, the operation can only proceed by the full Sap, but from as many heads as possible; when very near, say 50 or 60 yards of the covert-way, it is probable that the only resource will be by the full Sap, during the day; but at night, even then, there will probably be many opportunities of advancing at periods by the flying Sap.

A Third Parallel is usually constructed at about the foot of the glacis, the nearer the better; and subsequently, Demi-parallels for intermediate supports, and cavaliers de tranchée, to gain a *commanding* fire into the covert-way; and even a Fourth Parallel, all according to the power that the besieged are enabled to put forth in their defence, which however must be very obstinate, and the Artillery means of the besiegers inefficient, to render the two last resources necessary; particularly the cavaliers de tranchée, which are very troublesome to construct.

The nature and position of these several works will be best seen on the accompanying diagrams. Plate II. figs. 1, 2.

When the approaches are on the glacis, the enfilading batteries become very much masked, entirely so as regards their effect on the covert-way; and unless the artillery be very ably served, even on the faces and flanks of the works within the ditch.

At this time pierriers, howitzers, and the small mortars, are established in the advanced works * to act as substitutes.

The effect of this change of system, however, generally favours for a time the besieged in making renewed efforts to oppose the progress of the Attack.

Portions of the Third Parallel are prepared with steps to enable the troops to march out in order, when required, either for attacking any work, or to oppose sorties. Plate II. figs. 1, 3.

Formerly, the crowning of the crest of the glacis was generally forced under a heavy fire from the garrison, and at a great loss, and was then the most delicate and uncertain operation of the siege; but this has been since superseded by the more effective employment of Artillery, which enables it to be gained by the Sap, and without even much delay; the mass of shot and shells dropped into the covert-way during the progress of the siege effectually ruining the interior palisading or other slight intrenchment, which may alone enable the garrison to occupy the covert-way in force, and to attempt to hold it obstinately.

The garrison being driven from the covert-way, the breaching batteries against the faces of the works, and counter batteries to destroy the parapets of the flanks, are constructed along the crest of the glacis.

In some cases, where the escarps cannot be seen from that position low enough for

* Retrenchments of slight walls, or of palisades, might have light guns brought against them, or perhaps even heavy rockets, so as to hasten their reduction earlier than could be effected by waiting to put the heavy guns in battery.

breaching, it is necessary to construct the batteries for that purpose in the covert-way, an operation attended with more difficulty, and leading to the artillery being in a more confined position, and more exposed to suffer from shells.

During the time of constructing and obtaining effect from these batteries, the passages down to and across the ditch are made.

The communications to the ditch may be made either by blowing down the counterscarp wall and forming ramps down,—or by galleries from the glacis down to the level of the ditch, made on the system explained under the head of 'Mines;' or if there are sufficient means and time, both might be adopted,—the galleries for ordinary service of the Sappers and progressive work, and the open ramps for storming parties.

Where it is necessary to make lodgements and batteries on the breaches of outworks, the passage across the ditch and up the breach is carried on by Sap, full or flying, according to circumstances.

Though the besiegers are, in these latter operations, advancing in confined spaces, and with narrow fronts and little cover, still their position is so commanding from the crest of the glacis, the covert-way, and the outworks, as in succession they become possessed of them, and the garrison of each work attacked consecutively, so confined for space, and either so weak in numbers, or if otherwise, so exposed to the vertical fire, while timely support is so difficult to be given them, that the result is usually a question merely of time.

The passages across wet ditches must be made by filling them up for the necessary width and height; the rubbish from the breaches and from the communications down to the ditch tending towards them: the rest is either of fascines or earth.

Where there are running streams through a ditch, it will be necessary to leave sufficient openings for the current by a connecting trestle-bridge; or perhaps side channels may be possible, to afford another course for the stream.*

According to the ordinary modern system of Attack, it is seldom that any Assaults are made, but the final one for taking the place, but the breaches are successively occupied, and lodgements made on them by the Sap.

The exceptions are, where a work being once taken is irrecoverable, such as enclosed detached redoubts, or outworks, which can be assaulted while their communication with the garrison is cut off or rendered too difficult to be re-occupied.

In the first case, the redoubt is, as regards the effects of an Assault, reduced to its own isolated means; in the second, the possession of the work will be in the hands of that one of the contending parties which has the easiest communication to it: thus an outwork that is under the fire of the place, and not breached, cannot be held by the besieger; nor can one that is breached, and without an intrenchment perfectly closed against a coup de main, be held by the garrison.

An intrenchment connected with the parapet of a work is no security against an assault, as it will be turned by the parapet, and its garrison driven out with loss.

It does not follow, that because an outwork is taken by assault, that it will continue to be occupied under the fire of the place; the object will be to drive the garrison in from the immediate propinquity, while the communication to the work, and lodgement on it, shall be made secure.

The final Storming of the Fortress takes place when the breaches are practicable, and there are no obstacles left that can, in the judgment of the besieger, prevent his masses of troops penetrating completely into the place.

The assembling situations for the storming parties and supports are arranged, and

* Lieut.-Colonel Blanshard's Infantry Pontoons must now be the resource for crossing wet ditches. —*Editors.*

the communications from them to the breaches, or points of Attack, made ample and good.

Taking the hint of the premature explosion of the shells, powder-bags, &c., &c., (prepared for the defence of the breach at St. Sebastian,) by the heavy fire of artillery opened immediately previous to the last Assault, the success of the operation will be much more certain, if, as a prelude to the Attack, a concentration of all the fire that can be brought to bear takes place; especially that of mortars, with not only shells, but carcasses, so as to ignite the usual defensive contrivances before the troops appear. The large carcass rockets would probably be of service by, in addition to the above, searching the breach for mines and fougasses.

After the works are gained, and the town, or interior of the Fortress open, the storming party and supports are re-formed, and directed in the manner best calculated for securing the garrison, or driving them into any citadel or interior hold, till when the operation must be deemed incomplete.

This is particularly necessary for Night Attacks, and more especially for the Assault of a Fortress by a coup de main.

In the latter case, if the garrison can rally and repel the assailants, the entire object is defeated, as occurred at the storming of Bergen-op-Zoom, by the British forces, in 1813.

At all Assaults, the main body is always accompanied by at least one Officer of Engineers, not to assist in stimulating the party to actions of vigour, although they usually do not fail in that respect, but to afford the advice to the Officers in command which he is enabled to give from his superior knowledge of the nature of fortification, the combination of the several works, and generally of the resources of attack and defence.*

It is usual in Assaults for the advance, (or forlorn hope,) conducted by the Engineer, to precede the main body by, perhaps, 20 paces. The support follows the main body at, may be, 100 paces.

This Article has been written entirely with reference to the Attack of fortified places, as they existed up to the termination of the last great continental wars.

Since then, new and improved systems of fortification have been adopted to remedy the ascertained defects of the old ones; and several have been, or are now, in course of construction, which will hereafter require to be attacked by new proceedings in many respects.

These new principles of fortification have not been sufficiently classified nor analyzed, to enable any decided view to be taken of the manner in which it will be expedient to attack them.

Where they are small, it is probable that in removing some defects the constructors will have fallen into others, of which the besiegers will be able to take advantage.

Where the fortresses are large, (which is the more common case,) the very size, when properly garrisoned, rendered in former days the siege of them at any time so difficult, that it is not to be supposed, but that the exhausting of all the resources of the Engineer's art, and the expenditure of very large sums of money upon them, will have rendered them almost impregnable.

At all events these new fortresses are rare, and for one that will have to be besieged, there will be twenty on the old systems, and for which the present principles of Attack will have to be applied.

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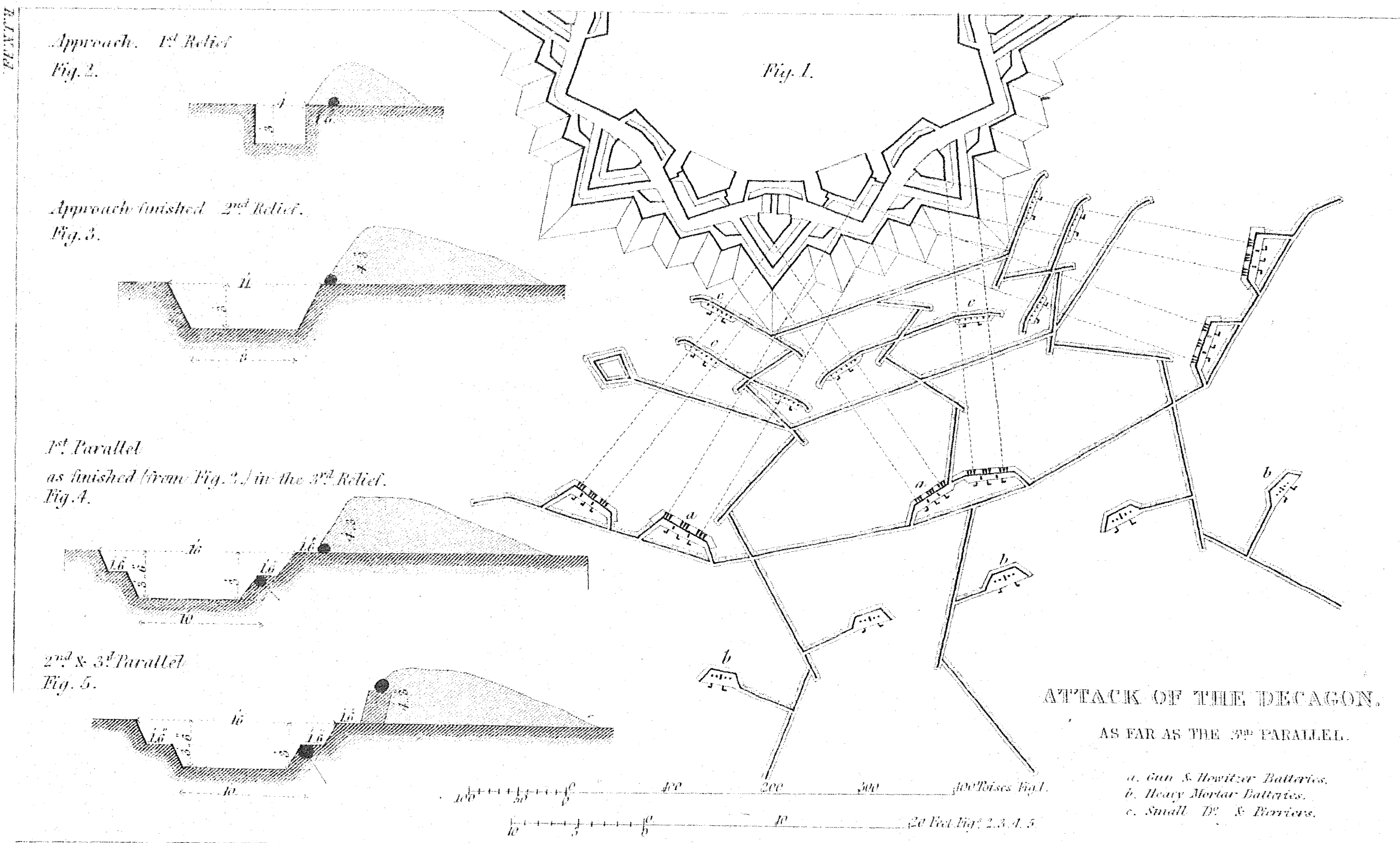
* Vide also the article 'Assault.'


ATTACK OF THE DECAGON.
AS FAR AS THE 3RD PARALLEL.
a. Gun & Howitzer Batteries.
b. Heavy Mortar Batteries.
c. Small Do. & Perriers.
Fig. 1.
Approach. 1st Relief
Fig. 2.
Approach finished 2nd Relief.
Fig. 3.
1st Parallel
as finished (from Fig. 3.) in the 3rd Relief.
Fig. 4.
2nd & 3rd Parallel
Fig. 5.
100 50 0 100 200 300 400 Toises Fig. 1.
10 5 0 10 20 Feet Figs. 2. 3. 4. 5.

R.J.N. del.

ATTACK OF THE DECAGON,

CONTINUED FROM THE 3D PARALLEL

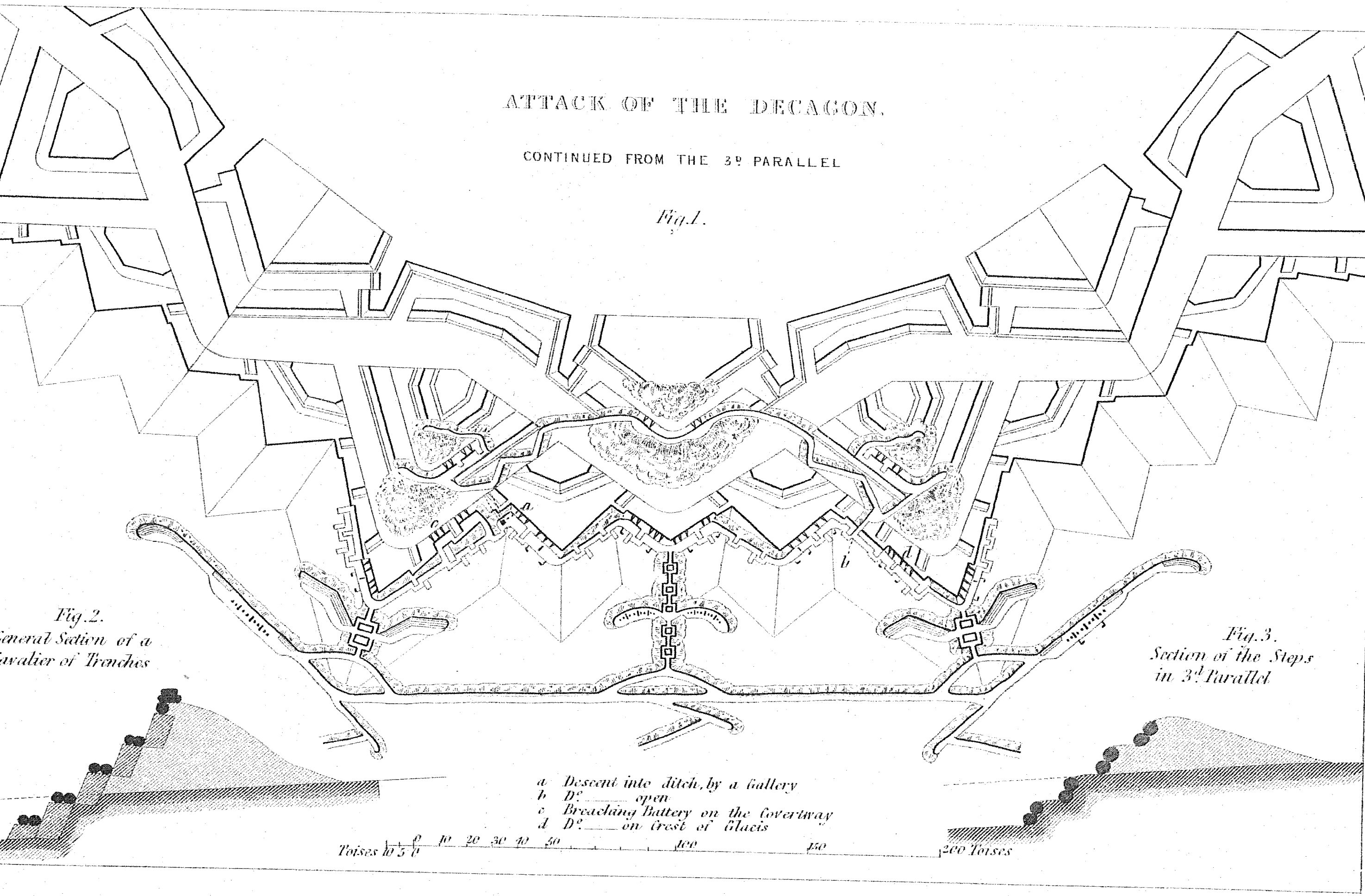


Fig. 1.

Fig. 2.
General Section of a Cavalier of Trenches

Fig. 3.
Section of the Steps in 3d Parallel

ATTACK OF POSTS.*

Temporary works may be attacked by SURPRISE or by OPEN FORCE, and it will be necessary to obtain accurate information on several essential points before a decision can be made as to which mode will be the most judicious or practicable under the circumstances. For instance, previous to making any dispositions for an Attack, either of a village, an intrenchment, or a smaller military post, a Commander should have some knowledge of the locale, the nature of the defences, and the strength of the force occupying them. It should be ascertained whether they are left to fight their own battle, or are in a situation to receive support, and from whence that support is to come,—how the duty is done,—what is the nature of the ground around it,—whether favourable for concealment or otherwise,—which are the shortest and best roads to it, &c., &c.

If an intrenched village is to be attacked, it should be ascertained by what means the streets and roads leading into it have been closed,—whether by stockades or breast-works,—how these obstacles are flanked,—whether from neighbouring houses or temporary works thrown up for the purpose,—what obstructions are placed in front of them, whether abattis, trous de loup,—how the houses forming points in the main enclosure have been strengthened,—whether there is a keep, and of what nature it is,—and how fortified,—whether there is any building occupied on the outside as an advanced post,—where the pickets are placed, &c.

If the Post is an isolated building, such as a country house or church, attention should be directed to the mode in which the doors have been barricaded, or the windows blocked up,—how the loopholes are arranged,—what sort of flank defence has been obtained,—how it can best be approached,—what internal preparations have been made for prolonging the defence, &c. Part of this 'useful knowledge' may be drawn from spies, deserters, and maps, not however trusting any of them much further than they can be seen or verified; and for the rest, there is nothing comparable to seeing for one's self, and therefore either an open reconnoissance, or a secret peep, must somehow or other be obtained.

These hints will suffice to shew that there are a multiplicity of objects which require to be looked to, before an opinion can be formed as to the best course to pursue; and unless some previous information is obtained upon some or all of them, false calculations will necessarily be made, unexpected obstacles will be encountered, and hazardous enterprises will be undertaken, all which might at least have been modified. With superior numbers in hand, and no very great show of opposition in front, it may be difficult to exercise patience, and just finding out what one has to encounter, both before and behind the little level lines of parapets and palings. There may be some great yawning ditch, either 'to you,' or 'from you,' which it is not so easy to take 'in your stride.' And things are not always quite so smooth as they look; it is therefore better to find out if you can, and prepare accordingly.

The dispositions for the Attack, of whatever nature it may be, though they require to be made with great circumspection, and executed with the utmost celerity, decision, and effect, do not perhaps call for so many precautions as are necessary for the defence of a work. It is with the assailants to choose what they will do,—with the defenders,—on very short notice, to conform and make the best of it. The first object of an Attack is to get—*at* the people who are defending a work, and then—*to beat them.* To secure the former, a Commander would naturally seek for a point which presented the fewest obstacles, and when he saw where to strike the blow, he

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* By Major Jebb, R.E.

would accomplish the latter, by hitting 'uncommon hard,' so hard as to make his adversary reel under it, if it did not knock him head over heels, and get rid of him altogether. These main objects being kept in view, every thing that would conduce to secure them must be studied and carried into effect. He would therefore arrange his plan with the utmost caution, and execute it with corresponding vigour. It will be obvious, that where it is practicable, several real Attacks, or one *leviathan* and several false ones, will distract an enemy's attention,—divide his forces,—tend to disturb him and shake his confidence,—render his combinations more perplexing, and, in short, give him more to attend to, with diminished means of doing it, than if one Attack only were made. It is usual, therefore, where circumstances permit, to attack several points at the same moment, or in quick succession. To effect this, the columns are formed under the nearest cover that can be found, from which they advance with as much celerity as will leave the men *fresh* when they get to work. To regulate even this properly is a point of no small importance;—for instance, if a column has any considerable distance to move, in the face of a smart peppering fire, and they start at too great a pace, they may be brought to a stand still, before they can close with their opponents, and that too when the fire upon them, from its diminished distance, is the more deadly. The means of moving *powerfully and swiftly at the last* must be preserved at all events. This forward movement is covered by Light Infantry, who would halt on the outside of the ditch or other obstacle, and whilst the column was engaged in getting over it, would endeavour, by good steady shooting, to aid the operation in keeping down the enemy's fire, or putting down any overt acts of opposition on the part of the defenders. It would be a weak proceeding to permit any of the men *in the column* to amuse themselves by firing; and, to prevent disappointment, it might be explained that they have much more serious business to attend to with the bayonet, and till that is done, they should think of nothing else. Any little *decided leisure* might be so employed by a few of the leading files being disposed in front for that purpose, whilst the others were lying down to cover themselves; but the main point should never be lost sight of, no time should be wasted upon it, for the assailants and defenders, under such circumstances, are far from being on equal terms; the former being exposed from top to toe all in the open, and the latter at the worst would be covered up to their chins.

Each column designed for making an Attack is usually divided into two parts, the relative strength of which must be determined by the nature of the operation,—the number of the defenders,—and a train of probabilities too long to be enumerated here. One party is for storming the work, and the other is placed in reserve, to be applied as events turn out, either to assist in following up and taking advantage of success, or as 'a friend in need' to fall back upon, in case of disaster. The former of these parties may be again subdivided into two or more parts, one for the first onset and the others for support; but this should be more *nominal* than *real*. The question is, shall we send the whole storming party on, in one mass, or shall we first *start* it in separate detachments, and then let it *finish* as one mass? We require the moral as well as the physical effect which NUMBERS will produce, in order to penetrate the enemy's line, but if we can secure those essentials when wanted, it does not appear necessary to expose the support or the *tail* of the column, whilst any work is going on which the *head* of it, or the real storming party, can effect just as well by itself. For instance, there would be little good gained by a vast body of men being halted under a close fire, whilst workmen were engaged in cutting a road for them through palisades or an abattis, or whilst the leading files were rearing ladders for an escalade, &c. The *moral effect* and confidence produced by *numbers*, which it is most essential

to study, would be still retained if the *head* of a column could feel assured that it travelled with its *tail* on, though it could not see it, and that however fast the one might move, the other would be certain to follow: and the *physical effect* or *force* that is required for an onset, would be equally secured by the same means. Numbers are in either case the chief ingredient; the only thing to be considered is, the proper application of them. This is confessedly rather a nice point to manage, and such as it is more easy to theorize upon than to carry into effect; but if troops are handy, and are accustomed to work together, and to be *sure* of each other 'in sight and out of sight,' and that their efforts are directed by the hand of a master, there do not appear to be any impossibilities attending its adjustment; at any rate the principle, if true, is not falsified because the practice is difficult. In Night Attacks, for example, it is especially necessary that all the arrangements should be the simplest possible,—and under such circumstances an undivided force would be preferable to risking a mistake being made in the administration of separate parts of it.

In carrying out the principle of the storming party and its support marching separately, we ought to find that as the leading files of the former became engaged, or as the explosion took place which was to blow the barrier to atoms, by which they were to enter a work, the supporting column should be close at their heels,—to add their weight to the first shock,—to inspire confidence,—join in the cheers,—and be at hand to rectify any thing that might happen to go wrong. These little delicacies cannot be brought within the precise limits of any rule which shall be of general application, whether as respects distance,—or time,—or pace,—or any thing else. It is the Commander who has the right kind of head on his shoulders, and an eye that is good for something in it,—who can alone apply the principle, and regulate them on the spot.

Troops aided by musketry in the manner adverted to, would plant ladders for escalading,—Sappers would cut away palisades,—blow open barriers or gates,—make steps in slopes that were too steep to be ascended, or clear away impediments, and a steady charge would then take place. Not one man running at the top of his speed and another after him,—that is not the way to get rid of a set of resolute fellows. It must be a steady charge, or rather a quiet determined rush; the whole weight of the column is wanted to make the desired impression in the adversary's line; and if it is frittered away bit by bit, much of the effect is expended in individual acts of heriosm, which might be more usefully employed. Where several Attacks are made, the columns may as well all march on the same front, of subdivisions, or a greater or less formation as might be convenient, as it will make it more difficult for an enemy to estimate numbers, or distinguish the real from the false attacks; and the latter should look and act as if they intended mischief, however innocent their designs may be. They should also be of such a strength as to command respect, and in order that they may be in a condition to profit by unforeseen success; the *number* of attacks should therefore be in proportion to the force that is to be divided. How frequently has it happened, that a false attack which would have been considered as too rash and hazardous an enterprise to be thought of seriously for a moment, has been crowned with a success, which has equally astonished friends and foes, whilst others which have been judiciously planned and organized have altogether failed!

It is explained further on, that the 'top o' the morning' is not a bad time for making an Assault; this is chiefly because the previous movements are concealed by the darkness, and the loss is diminished in proportion. For instance, under favourable circumstances, it would be quite possible, after driving in an enemy's pickets the preceding evening, secretly to dispose a firing party close to the ditch on the outside

of a work, without a hostile shot being fired, (for they are not always prepared for illuminating the exterior by light-balls,) and to have a column at no great distance waiting for the precise moment that was most favourable for the Attack; and when the troops did advance for an escalade, or whatever the operation might be,—what would happen? The alarm would be given, and the parapets would be manned; but opposed by a firing party, drawn up perhaps three deep within a distance, it might be of 20 or 30 yards,—who could shew himself to give his fire? Let us see the man that would be long 'in easy circumstances' with his head and shoulders above the parapet! If sand-bags had been disposed for protecting the defenders, a few shots might be fired through the loopholes, but their effect would be as nothing. Only those directly opposite a column could be brought to bear at all at that distance, and with good arrangement there would be no time for mischief to ensue, even if there were more opportunity.

Circumstances, however, will arise when an undisguised Attack in broad daylight may be imposed. There is of course more previous *exposure*, but people *see what they have to do*, and can therefore act with more decisive effect. In the preparatory movements, and during the advance of the columns, violence must in this mode of attack control opposition, instead of its effects being eluded by secrecy or concealment. The employment of light troops and artillery are the chief means which may be applied by the assailants for effecting this object; the former can act as a firing party under any circumstances in covering the advance, but it is quite necessary there should be light enough, in order to derive all the benefits which the latter can bestow. Artillery can effect that from a distance, which without it Infantry would have to execute for themselves, under all the disadvantages of a close fire. Thus by firing in a slanting direction at stockade-work,—an abattis,—or palisading,—these obstacles become so damaged and torn up, that a passage improved by the use of the axe is readily effected through them. Barriers may be knocked away from doors or windows,—walls may be breached, or the defenders in a building may be very much incommoded by its effects; for shot will go through and through ordinary houses, and if a lively fire is kept up they soon cease to be comfortable quarters. By firing shells into parapets, that portion which covers the defenders may, if time admits, be partially got rid of, and when all these good things are effected from the front, the guns being moved to one of the flanks, so as to obtain a general enfilade, may keep up a fire till the moment of assault, which will unsettle the defenders and insure a corresponding advantage to the Attack: in fact, it is difficult to say what a brigade of Horse Artillery or a battery of 9-pounders *cannot do* against a military post fortified in haste, or indeed against any thing else.

The principles on which Attacks are conducted, and the general arrangements for executing them, will be gleaned from Jones's 'Sieges,' in the example of two assaults on Fort Christoval.

SURMOUNTING OBSTACLES.

In the Attack of Military Posts, especially such as are of minor importance, Infantry are more frequently than otherwise thrown entirely upon their own resources, for forcing a passage through whatever obstructions they may fall in with, before they close with their adversaries. They have then no guns or howitzers for tearing up and destroying stockades, abattis, palisading, chevaux-de-frize, &c., and have only to trust to their own exertions for getting to the *right side* of them. The nature of the obstructions which are usually employed for adding strength to fortified Posts, are detailed in article 'Defence,' and the means to be adopted for surmounting them will now be briefly adverted to.

HOW TO DEAL WITH AN ABATTIS.

An Abattis is probably the first obstacle a column will fall in with, and an awkward obstruction it is, if it has been properly managed, and the materials have been of sufficient size and weight. In an Attack by surprise, an endeavour should be made to get round the flank of it, and if that 'won't do,' the men must try and crawl through it in the best manner they can, avoiding any noise, and forming again as they succeed.

If the Attack is by open force, and the abattis should prove impenetrable, there is no harm in making the attempt to set it on fire. A few resolute fellows, carrying small fagots which have been previously dipped in pitch, and each man provided with a 'lighted portfire,' if it is day-time,—or if they can approach unseen by night, with some other means of setting fire to them,—must rush up from some neighbouring place of concealment, covered by a smart fire of musketry, and throwing in their lighted fagots, all will soon be in a blaze. When that has subsided, and there is no fear of the men's pouches being exploded, the breach will be practicable, without waiting for the hot cinders to cool. This little conflagration would go on under the protection of a party, near enough to prevent any attempt on the part of the defenders to extinguish it. If, however, an abattis is formed of small materials, or if sufficient precautions have not been taken to secure it in its place, (that is, if it is *a bad one*,) it will be a waste of time to submit to the delay of burning it: in such a case, a party rushing up with ropes, may tie them to some principal trees; or a big hook fixed to a rope or pole may be used, and a tree or two may by these means be dragged forcibly out of the line; or some handy fellows with good tools may partially open it, by cutting away a few of the small branches, so as to let men get through at 'open order.'

HOW TO OVERCOME OTHER IMPEDIMENTS.

If the obstructions outside a Post consist of military pits, stakes, or the stumps of trees, &c., they may be passed at 'open order,' if they cannot be avoided, and the columns be re-formed as soon as possible. Small ditches may be filled up with fagots or bundles of hay,—chevaux-de-frize may be displaced by main force, with a rope and a good pull altogether,—or they may be cut up, or blown to pieces with a bag of powder; palisades, or fraises in a ditch, may be got rid of in a similar manner,—or if a party is provided with ladders or planks, and the ditches are narrow, these last obstructions will frequently offer facilities for constructing temporary bridges for passing over them. Stockade-work or palisading may be escaladed with ladders brought up in a line under the protection of a firing party, and carried by two or four men, according to their length. The ladders would be planted as close together as they conveniently could be, and the assailants would mount them on as extended a front as their numbers permitted; or a stockade may be breached by the explosion of a bag of powder, &c. By some such means as these, applied with boldness and decision in a common sense sort of way, troops, assisted by workmen, would be a match for any of the ordinary obstructions which might oppose their advance, whether the attack were made by night or by day, by surprise or by open force.

OF ATTACKS BY SURPRISE.

A Post is said to be *surprised* when an enemy either gets into it, or close up to it, —by making a false or forced march, information of which has been concealed from the defenders, either by their own bad look-out, or their opponents having been favoured by fog or darkness, &c.; or it may be, that they have succeeded in quietly cutting off some advanced Post, which would have given the alarm.

When ably planned and carried into execution, a surprise is the best kind of attack

that can be made; there is less *exposure* beforehand, and from being unexpected, there is, from the nature of things, more confusion among the defenders, and therefore less *resistance* afterwards. The result also is generally more decisive, and smaller numbers can act with far greater effect against a superior force than can be hoped for in an open Attack. It is only, however, when an adversary fails in his precautionary measures that success can be confidently anticipated, even from the best formed schemes of surprise; and even then, without precise information as to the nature of the defences,—the strength of the defenders, and their measures of security,—without ascertaining the *degree* of caution and punctuality with which the duties are performed,—any attempt at a surprise would most probably fail.

Neglect in the *external* precautions of security, such as a faulty disposition of the outlying pickets and videttes,—the omission of patrolling, &c., *admits* of a surprise; and an absence of judicious *internal* arrangements will *facilitate* it. The first will consist in placing but few pickets, and those at too great a distance from each other, and too far to the front, so that the chain becomes unconnected, and the communication between them is not properly preserved; or in falling into an opposite error, of placing them so near to a Post as that they do not secure sufficient notice of the presence of a hostile force, to enable the defenders to stand to their arms; or it may be traced to a slovenly manner of carrying on the outpost duty generally. The second will depend upon the degree of discipline and readiness prevailing among the troops generally, and the dispositions that may have been made for applying their services in the most effective manner, and in the shortest possible time, &c. The following are likewise circumstances that will favour this mode of proceeding.

When there is a wood or ravine within a moderate distance of a Post,—when you have the power of secretly assembling a force equal to the undertaking, which was before dispersed with a different object,—when the defenders think themselves in security, either from your distance or circumstances, and are therefore less on their guard, and less vigilant,—if the Post is not quite complete in the works designed for its defence,—if the troops are raw, and their chief not much better,—or if from being deemed inaccessible, when that fact is fabulous, any part is not so well guarded as others,—these are all very tempting circumstances to try one's luck at a surprise.

Secrecy is the soul of a surprise, and as a secret is liable to 'fructify' when in the hands of many, the less that is said about any intention of beating up a neighbour's quarters the better. Your enemies must, of course, be deceived, or kept in ignorance, and until the moment when their exertions are required, it would be quite as well for your friends to be so too. The requisite preparations therefore in collecting ladders, tools, &c., should be shielded under cover of being for some other distinct operation, and plausible excuses given forth to allay suspicions as they arise.

Among other considerations, it will have to be decided beforehand whether the Post is to be held and defended, should it be taken, or whether it is to be destroyed or abandoned. In the former case, a temporary supply of provisions and ammunition should be thought of; in the latter, the attack and retreat only have to be provided for.

Winter is the most favourable time of the year for attempting a surprise. Sentries are not usually so much on the alert in cold weather, and the long nights and the storms and fogs, which prevail at that season, are all 'accessories before the fact.' A night when the moon sets just before you want to begin the Attack is advantageous, as the previous movements will have all the benefit of the light, and the succeeding darkness may serve an equally good purpose.

It is generally admitted, that the peep of day is, under most circumstances, very favourable for making an open Attack, when there is not light enough to betray the

advance, or any of the preparatory movements, and the assailants have the advantage of daylight immediately after to profit by success, in securing all the advantages they may have gained. But an enemy knows this as well as anybody else, and the whole disposable force of an army or garrison is generally under arms at that time, and probably more on the look-out than at any other hour of the twenty-four. This, therefore, is not the best time to catch them unprepared, and it would appear, that getting up a little earlier, or sitting up a little later than one's adversary, would afford a better opportunity. As to time, therefore, soon after midnight would probably be the hour; and if it could be made to square with the object in view, which may vary with circumstances, it would probably be as favourable a time for the attempt as any other: for example, if the Post were at no great distance, and the intention was to destroy and then abandon it, before succour could arrive, a better hour than midnight could not be selected, as it would afford the opportunity of accomplishing the object, and making good the retreat before daylight. But if the Post were to be held afterwards, the dawn of day immediately after the assault would enable a party to make better arrangements for defending itself, and a later attack would therefore be preferable.

From these considerations it will appear that a surprise, whether early or late, generally entails a Night Attack, and it is scarcely necessary to say that the greatest precautions, and the very best arrangements, are required for carrying it into effect; nor can success be reasonably looked for without them. The worst of going to work in the dark is, that unless the point to be attacked is of a nature not to be mistaken, it is ten to one, the attempt to identify what is doubtful will disclose all. Nothing can be worse than having to poke about, especially if you don't want to be found out, which is rather an essential in a surprise. Again, when you have forced an entrance, we will say into a village, unless you are perfectly acquainted with the interior, and familiar with every object that presents itself, there are other and great disadvantages to contend against. The local knowledge of the defenders is all in their favour,—the offensive cannot be continued with vigour, and nothing is gained in furtherance of your object by standing still. Dangers are magnified in the dark, especially when men are not excited; and as a resolute enemy will know exactly where to strike the blow, and you can neither see from whence it comes, nor estimate its force, till you feel its effect, it may become necessary to assume a defensive attitude; and this, under the circumstances, may lead to a reversal of your previous success. If there is work to do with the shovel and pickaxe, such as effecting a lodgement for establishing yourself on the ground that has been gained, or for other purposes, the darkness is favourable for the execution of it; but this does not affect the present question. Under any circumstances, however, the value of the local knowledge, which is conspicuous among the useful items adverted to, will be apparent, and with other hints which have been thrown out, will serve to create a suspicion that there is something for a Commander to think of, before he makes up his mind to commit himself in action.*

The number of men for an Attack ought, under most circumstances, to be superior to the force of the defenders, which it must not be forgotten have the 'vantage ground; but in a well conceived and vigorously executed surprise, very inferior numbers, profiting by the confusion and astonishment which are inseparable from an unexpected Attack, have done '*impossible things*,' and doubtless can do so again; which it is as well to remember when any similar opportunity should happen on

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* Surprises in the open day can seldom be successfully undertaken, except in mountainous countries, intersected by ravines and hollow roads, &c.

service: generally, however, numbers are one principal ingredient in success, and therefore the means for the Attack should be adequate to the object, taken in all its bearings. A very inferior force may possibly make good their footing, against all opposition at any certain point; but the question may be, can they maintain it?

This question arises with a greater or less demand for an answer in the affirmative, according to circumstances. For example, a modest Commander may prescribe limits to his ambition, and merely wish to set fire to a Post,—a village,—or dockyard, or to blow up a magazine, or some other equally inviting subject, and then peaceably to retire, without any desire further to trespass on the time or attention of his opponents. A few minutes' possession of a certain spot might suffice for the accomplishment of any of these purposes, and it might be that a very few men would be sufficient to force an entrance and effect them. In a well concerted surprise, a small force might possibly be brought almost within arm's length of the desired object without discovery, and when a rush was made for securing it, there might be all the routine of sounding the 'alarm and assembly,'—of turning out guards,—and probably some marching and counter-marching to perform, before the nature of the Attack, or even the point or points where it was made, were clearly comprehended by any large body of the defenders; and before they had rubbed their eyes, and made their dispositions for repelling it, the deed might be done, and the actors be on their way home again.

If however the Post which is attacked is to be held afterwards, '*c'est une autre chose;*' defenders have an unpleasant way of sometimes recovering from a first panic, and then the preponderance of force should be on the right side, or 'the tables may be turned.' There have been instances, however, quite within the memory of the present generation, of a very inferior force surrounding a respectable work strongly garrisoned—carrying it by assault in the night, and making the defenders lay down their arms before daylight told any tales as to the disparity of numbers.

The success of such enterprises as these, which have for their object to effect what greater numbers ought to be employed about, depends entirely on the advantages resulting to them from a complete surprise, and coming upon an enemy when he is quite unprepared: in fact, if this is not done, the attempt ought to be abandoned at once.

The execution of an Attack of this nature is rather a delicate affair, for if by any means the suspicions of a vigilant adversary have been awakened, he will have made such dispositions as might cause the surprise to be felt on the *wrong* side. If, therefore, there should be the least cause for suspecting that an enemy is playing tricks, every possible precaution should be taken for ascertaining the truth, before getting into a difficulty, which it might not be easy to get out of. The main body should be halted at a greater distance than it is likely an ambuscade would be sent, and the whole ground in the front should be '*felt*' with the utmost caution by patrols, who, if not stopped by outlying pickets or videttes, &c., should creep close up to the place, listening to every thing that is going on. If on their report it should be decided to move on, it would still be prudent to do so with all circumspection, having an advanced guard composed of men who know what they are about, and parties with the same view to protection on either flank. If, on the contrary, there were good reason to believe that the enterprise was no secret, and that every thing was in readiness to give you a warm reception, it would depend upon circumstances whether 'prudence' would not be 'the better part of valour.' These observations of course only apply to a force quite inadequate to any open attempt; but with a proportionate force, should there be a failure in the design of surprising a Post, the probability of which would have been foreseen and provided for, it would only be necessary, under such circumstances, to throw off the mask,—proclaim yourself an open enemy, and

fight it out, which all your previous arrangements would enable you to do without difficulty.

The whole force employed, whatever it may be, should be divided for fulfilling specific objects. Several columns of Attack may have to be formed,—some for false, others for real Attacks, each to be closely followed by its support: there should also be a certain force posted in reserve for covering a retreat, in case of failure; another, probably, for guarding particular points, in order that, should your designs have been anticipated, you may not be surprised in your turn by an attack in flank or rear. Men with axes, sledge-hammers, crow-bars, &c., for forcing barricades, or cutting away obstacles, and a few bags of powder with fuses attached, for bursting open gates, would likewise be useful. The troops employed on these little enterprises should be picked men. Guides, if they can be depended on, will be necessary in sufficient numbers to allow two or three to accompany each party, but *personal* knowledge in the assailants or their leaders is a better thing, and more conducive to success.

Whatever may be the time or disposition that is decided upon, the march must be so ordered as that the column or columns shall arrive at some point in the immediate neighbourhood, perhaps a mile, or a mile and a half distant, an hour or more before they will be wanted, so that the last orders may be given, and the final arrangements be made; for there is generally a parting word to say on these occasions. This arrangement for the march presupposes, that all the requisite information respecting the situation of the pickets,—the mode of patrolling,—and the general *external* precautions for guarding a Post, have been obtained, so that a Commander knows what he is about, and can put his different detachments in movement for the several points he intends to attack. But if this information has still to be sought, in consequence of the enemy's pickets being posted differently every night, or other causes, the troops must either be brought up earlier, and wait till these points are determined; or a patrolling party must precede them, so as to get there at dusk, and have it all ready. In the former case, arriving at the halting-place by such roads as afford the best means of concealment, some steady and intelligent men should be detached to patrol to the front; first to ascertain, if possible, the situation of any pickets which might have been posted wide apart, and then to find out the order in which the videttes were placed,—the mode of patrolling between them,—and any further information that could be obtained. The success of the enterprise depends upon the chance of introducing the whole force unperceived within the chain of pickets. The state of the weather will materially facilitate this preliminary step; and when it has been accomplished, the advance should be continued until the columns are discovered by the sentries of the Post, when a general rush would be made, and the more impetuous the Attack, the more favourable for the object, of following up the *surprise* by an easy *conquest*.

DISTRIBUTION OF THE ASSAILANTS, &c.

A multiplicity of considerations will influence the distribution of the assailants, so that it is hopeless to lay down any rule of general application; but we might say on a broad principle, that it would not be prudent to divide a small force too much in attempting false Attacks, and that therefore, from one-half to two-thirds of it might be formed for the assault, keeping the remainder in reserve for covering the retreat, and acting according to circumstances;—or were the force considerable, and the Post to be attacked of corresponding extent, such as an intrenched village, perhaps one-third of the numbers might be formed for the principal Attack, another third be divided for two false Attacks, and the remainder be left in reserve for the purposes before stated. In the former case as a minimum, the assailants should be at least equal in numbers

to the defenders; and in the latter, as the force is more divided, there should be a proportionate increase; that is to say, the numbers engaged in the three Attacks should be stronger than the garrison. A part of the force engaged in the false Attacks, or a portion of the reserve, should be placed not very far from the entrances to the Post that are nearest to the point where the real Attack is going on. These may be streets, roads, or gateways, &c., and they should be watched, that advantage may be taken of their being turned or opened; some workmen, who are 'good at need' for breaking open barricades, being held in readiness to accompany the party.

When all these particulars had been arranged, and the Officers or Non-commissioned Officers commanding the several parties had been made clearly to understand their orders, and the specific objects confided to them;—when the conduct they should observe under every emergency, both during the Attack, and in the event of success or failure, had been explained;—when the precise moment on which the Attacks should take place was perfectly understood,—and some conventional signal, countersign, or badge had been established by which men could recognize each other in the dark,—the columns would be in readiness to move on. The advance would be made in silence, and without haste; the columns dividing when they got near the place, and marching by the best route to their points, preceded by a few steady soldiers as an advanced guard, who would be on the look-out to secure any patrols or videttes they might fall in with, so as to prevent their giving the alarm.

OF THE ATTACK.

If the object of a column were to assault a field-work, which has usually a ditch bounded by slopes of earth, the advance of the storming party would silently slide down into the bottom of it, and if there were no obstacles, such as palisades, &c., and the slopes admitted of their scrambling up, they would form in the bottom of the ditch in subdivisions, or sections, as might be ordered, and endeavour to go up together without straggling; the remainder of the party following them as closely as possible; the support being halted at the edge of the ditch, ready to fire or advance, and the reserve being posted further off.

If there were unforeseen obstacles, which could not be got over or removed without the noise of workmen, the secrecy of the operation would be nearly over, and it would be time to awaken the *astonishment* of the garrison. A few preparations being made, such as the storming party lying down opposite the spot, and the support or a firing party, on either flank ready to keep people off the top of the parapet, the workmen would glide into the ditch, and first distributing themselves judiciously, and finding what was to be done, and the best way of doing it, they would commence work together, and regardless of any thing that might happen, would lay about them till they had accomplished their task; when the assault would immediately be given, and the endeavour would be made to charge in column, through whatever force was formed for the defence of the parapet: when this was accomplished, a halt would be made, to re-form for further operations in following up the advantage gained.

After troops once move forward to the assault, the bayonet should be called upon to do all the work; very little is gained by the leading files firing down upon the defenders from the top of the parapet, especially in the dark, or the grey of the morning. It only has a tendency to check their speed at the moment it is of some use to them. The assailants are at that time exposed, and perfectly visible against the sky, when the defenders, however near, could not be seen; and after the first man has jumped down within a work, his comrades must, of necessity, cease firing; therefore any thing that would be gained by permitting its use, would be more than out-

weighed by the inconveniences that would be entailed. It is usual, therefore, to make use of the bayonet only on these occasions.

If a wall, or any other obstacle of a moderate height, had to be scaled, the ladders would be carried by the advanced party, who would plant them side by side, and after it being ascertained that all were properly in their places, the troops would advance up them, in the most compact order, and on as extended a front as possible, and jumping down inside, would form again and move forward, as soon as circumstances permitted. Stockade-work might be scaled in the same way.

BLOWING OPEN BARRIERS, &c.

In the Attack of gateways or houses, if secrecy is preserved till you get close to them, it is as much as can be expected. In order to force the barriers or doors, the most effectual agent is a bag of gunpowder. A bag containing from 20 to 30 or 40 lbs., according to the expected strength of the obstacle, and furnished with a fuse for firing it, and a loop to hang it by, can be easily nailed or hooked up against a pair of gates, or fastened to a barricaded door. If it can be done without previous discovery, so much the better; and for effecting this, a gimlet will be found a very useful, quiet operator. When fixed, the fuse is lighted, and the man retires a little. The party for forcing an entrance may be drawn up within 15 or 20 yards, and a few expert men with axes and sledge-hammers may be with them. The explosion will most probably do all that is required, and the ruins, if any remain to impede the advance, will quickly be got rid of by the workmen. If all this has been done in secret, it will be a great object to take advantage of the bustle and confusion that will ensue, by making a vigorous Attack. If, however, the secrecy of the operation is at an end before the bag is fixed, and this has to be effected by open violence, in spite of what may be attempted to prevent it, the best proceeding is for a strong firing party to rush up, and throwing themselves under any cover that might offer, to reply to, and endeavour to subdue, the fire that defends the point to be attacked; and when that slackened, the men with the bag of powder would make a run of it,—fix,—light, and 'be off.'

SECURING POSSESSION OF A POST AFTER A SURPRISE.

In the Attack of a village, or even a smaller Post, the moment an entry is made, a portion of the force should be detached to endeavour to communicate with the other Attacks, if there were any; and leaving a party in reserve at the point where they came in, they should secretly march, if the alarm had not been given, to secure the guards and principal avenues into the village. By thus gaining possession of the barricades or gates, they would be enabled to open a communication, by which a portion of the reserve, which should have been previously held in readiness, might enter. If they were discovered, and the garrison were assembling to oppose them, the same measures would be of advantage, and no time should be lost, in also making a furious attack on the main body wherever it might be forming, taking care, during the advance, to secure the means of an orderly retreat. The value of *local knowledge*, indeed its absolute necessity, is again apparent, for how could any of these steps be taken with the promptness befitting the occasion if this were wanting?

OF ATTACKS BY OPEN FORCE.

An Attack by open force is imposed when something like the converse of all the circumstances that would favour an Attack by surprise exists;—such as the ground outside a Post affording no cover for approaching it,—or when a Post is so well and

so vigilantly guarded,—or it becomes a measure of necessity, from having no choice left between an attack or a retreat, as might happen in a general action;—or an attack of this nature may be undertaken with confidence when the works are weak or unfinished, and where there are facilities for enfilading its principal lines with Artillery;—or when a Commander is known to be timid.

Most of the information required for judiciously planning an Attack by surprise, will be also of essential service when an Attack by open force is contemplated; in either case it is equally of importance that a knowledge of the locale should be previously obtained, and that the obstacles to be overcome should be carefully estimated, and compared with the means proposed for surmounting them, before troops are committed in the attempt: something must of necessity be left to chance and good fortune, but not too much. If a choice exists as to time, or should it so happen that circumstances permitted a force to evade any previous exposure, by attacking in the night, or before daylight, so much the better; but if the Attack is made in the open day, and there is neither natural nor artificial *cover* to favour the enterprise, the strongest and most energetic measures should be adopted to control or subdue the fire that would be poured in upon an advancing column, which is the worse treatment it has to endure, because it is in no condition for making a reply '*in kind*.' When the leading files get within arm's-length of the defenders, an exchange of blows may take place, but not before;—hence the advantage of a 'cloud of light troops,' or of a strong firing party, for the specific purpose of protecting columns engaged in the attack of works, of whatever description they may be.

Though there is a great difference in the two modes of Attack under discussion, because in one it is assumed that an enemy is half asleep, and in the other, that he is on the alert, and that all the means in his power will be developed to oppose it, yet in their *principles they are the same;* and as a notion of these principles and of further details may perhaps have been obtained from the preceding pages in which they are treated of, a repetition of them would be superfluous.

The points requiring attention and the dispositions to be made after a successful Assault have also been glanced at, and equally apply to the more open mode of Attack under consideration. But as an enemy will be better prepared for making resistance, the measures will require to be of a more decided character, and no time should be lost in following up the advantage of a first success. A reserve would be left at the point where the entry was effected, and according to circumstances strong detachments would be sent off to the right and left to follow the enemy and sweep the interior of the defences; leaving guards at every entrance of a street, road, or alley, by which they might be cut off. The gates and principal avenues opening towards the side attacked would be seized, and access given to troops from the reserve, which should be held in readiness to enter, and an impetuous attack would be made on the main body as soon as a sufficient force was assembled. If there were a keep, the Attack should threaten the communication with their stronghold, and if circumstances permitted, a rush should be made to cut off their retreat to it, or to *intrude*, by joining the party and going in with them.

ATTACK OF AN INTRENCHED VILLAGE.

It is sufficient to give a few practical observations upon the mode of attacking the chief works, in which we may suppose the strength of an intrenched village to consist; which will bring us in contact with fortified houses, or churches,—redoubts,—flèches,—or other earthen-works, some or all of which may flourish as independent posts, or form part of the contour taken up for the defence.

ATTACK OF A FLÈCHE, OR EARTHEN-WORK, OPEN IN THE REAR—A REDOUBT, &c.

All detached works, of the nature of a flèche, that are said to be open in the rear, are usually so far closed that they have at least a good palisading and barrier gate to shut them in; *au reste*, they are generally earthen-works, having ditches of a breadth and depth varying with their importance, either revetted or finished in slopes, with a palisade in the bottom. The rear, however, is generally the weak point, and it is left open, in order that it may be defended from some other work which sees into it. To assault such a work, if it is of considerable size, several columns of attack may be formed; the principal one, however, should be directed upon the weakest point, and it should be held in reserve, and if possible concealed, until the threatening attitude of the other attacks (which may be directed on the salient or the extremity of either face) shall have induced a corresponding disposition of the defenders; it may then come on in all its glory, and make short work of the palisade by some of the means before described, the other columns acting according to circumstances. If it should so happen that it was not expedient to attack a work of this description by the rear, —the general plan of operations would be reversed, and a show would be made of attacking that point, when in reality the principal effort would be made on the salient angle, or some other part, by a column kept out of sight until the attention of the defenders had been previously engaged.

If the ditch of a flèche or other outwork is bounded by walls, an escalade with ladders becomes necessary, for it is a long business filling up a ditch with bags of hay or any thing else, a dangerous one to jump into it when deep, and an impossible one to get out of it when you are there, unless the retaining walls are very insignificant indeed. If the ditch is not revetted, but still the slopes of earth are too steep for men to scramble up, ladders applied to them will answer the purpose admirably, and if ladders are not to be had, rough steps may be made by workmen accompanying the columns; all these operations being under the protection of a strong firing party.

If Artillery forms part of the force, a breach in the parapet may be made with shells, if time enough can be devoted to it; and the opposite ditch being enfiladed, to destroy the palisades, &c., a column has only to wait for a signal to rush forward when these objects have been accomplished; but even in this case, with every thing made so smooth, a false Attack, by distracting attention, could not fail to have a good effect.

The Attack on a redoubt, which is a work enclosed all round with a parapet, and supposed to be every where of equal strength, will be much the same as that of a flèche. The angles are the weakest points, and the attacks, whether false or real, should direct their march upon them.— See Jones's 'Sieges' and 'Attack of Fort Picurina.'

ATTACK OF A FORTIFIED BUILDING.

The planning and execution of an Attack on a small Military Post, such as a fortified building, will more generally fall to the lot of a young Officer than the comparatively larger operations against a village or redoubt, &c.; but however small the Post may be, if it has been judiciously strengthened and is ably defended, there is opportunity enough for the exercise of both talent and bravery in assaulting it. But let us have a fair fight with no Artillery on either side, so that we may see what has to be done, and how certain difficulties which are peculiar to the nature of such an operation are to be surmounted.

First of all we will suppose that with the aid of a good telescope he has made him-

self, and those under him, well acquainted with at least the nature of the external defences, &c. His points of attack are selected, and we will imagine that the little garrison is on the alert as to his intentions, and on the look-out to receive him; moreover that he has a fine sunshine to enliven his proceedings. He divides his force and forms his columns of attack, and the first onset is made on the principle and with the precautions already explained. We will suppose, too, that the obstructions on the outside are surmounted by some of the means detailed in the preceding pages, but here is a great staring house now before him, barricaded and loopholed from top to bottom, and full of people, and a very serious and inhospitable looking thing it is! If an Officer had not been able to procure accurate information of the mode in which this citadel of the post had been prepared for defence, or if he had not sufficient knowledge of localities to enable him to arrange the whole of his plan of operations beforehand, it would be better for him, after a successful attack on the external defences, to throw his force under any cover he could find for a few moments, whilst he took a glance at the remaining works, and was making up his mind what was best to be done; otherwise he would have to risk a wild and uncombined attack, which would probably entail considerable loss and might be a failure. It would therefore be his object, if possible, to reconnoitre the house all round; but should circumstances induce him to decide on directing his principal attack against some part that he could see from the situation he had first gained, he might take his chance in trusting a false attack on the rear, and leave it to be worked as seemed best for diverting the attention of the defenders. We will suppose that he is opposite an angle of the house, and under cover of some object within 50 or 60 yards of it, and that a little slope in the ground conceals his men when lying down. He observes that one side of the house is flanked by a window, and some loopholes which have been made in an angular portion of the same building, and that on the other side there is a door in the centre covered by a tambour made of rough logs of timber set upright; the windows on both sides are low, but a ditch has been cut in the front to give height, and they are well barricaded with stout timber, loopholes being left for firing through. He has brought with him six ladders 12 feet long, two bags of powder with fuses attached, and some good workmen with axes, crow-bars, &c.; besides a small reserve, to apply as circumstances may require.

He observes, that if he rushes up in the first instance, directly for the angle of the building, he will be less exposed to fire than if he faced either side, and he decides that this shall be his line; and as strong measures on these occasions are greatly to be commended, he makes up his mind to expend the two bags of powder, one in breaking up the tambour, and the other in blowing open the barricaded window,—then to effect an entrance by means of his ladders, through the window, and to force the door within the tambour by a liberal use of sledge-hammers and crow-bars.

It is of course a great object not to expose men to fire, unless their presence or services can secure some corresponding advantage. He therefore determines only to send those men forward, in the first instance, who will be wanted for fixing the bags of powder and firing them, and a very small detachment to protect them during the operation by watching any particular loophole. To provide against accident he tells off two men to carry each bag, and two others with lighted portfires for firing them, each party to be accompanied by six men, so that any loopholes which bear upon the situations where the bags are to be fixed may either be silenced or at least have their attention distracted. The success of the operation appears to depend greatly on the adroitness of the men who have charge of the powder, and he therefore has selected some smart fellows who know what they are about, and points out to them what is to be accomplished,—how it is to be effected,—and what particular duty each has to

perform. The columns of assault, too,—the firing party, and a reserve to protect the flanks, or fall back upon in case of accident,—would all be told off, as well as the party for the false attack; but no movement should be made till every thing was in perfect readiness. He would then explain the general plan of the Attack, and point out the position of the reserve and support, &c.; after which the detachment for the false attack might move off, going by the least exposed route to the rear of the building.

A favourable moment would be chosen for commencing operations. If there were any cover at all, the firing party might quietly distribute themselves opposite the two sides of the house to engage attention, rather than with any hope of doing damage, for a loophole is so narrow that it would require very good and very steady shooting to fire into them from such a distance as we have supposed.

The bags of powder would now be dispatched;—the two parties would make a sudden rush up to the angle of the building, and then dividing, there would be nothing left for it but to run the gauntlet as best they could to their separate points, either along the bottom of the little ditch dug to give height to the lower loopholes, or close along its edge. All this would be the business of a minute or two. The bag for blowing in the window would either be propped up against it with a thick stick, or it might be laid on the sill. That for forcing out the timbers of the tambour might be hung upon a single nail, driven in at the time, or the loop would be thrown over the top of one of the timbers. The men for watching the adjoining loopholes should stand as close as they could to them, not exactly in front, but a little on one side, and keep up a constant fire into them, avoiding exposure as much as possible, either from the loopholes on each side, or those which might flank the place where they stood. It would be a needless exposure of men, and the worst of two evils, to make a general attack on loopholes, unless under particular circumstances, where there was only one row, or that something had to be done which would require a party to remain exposed for a considerable time. In cases where there were two or more rows of loopholes, and the defenders had the means of throwing grenades, or rolling shells down from the upper windows, besides giving their fire, the means of attack would not be commensurate with those of the defence, and it would not therefore be prudent to attempt it; but on a limited scale, and when it *must* be done, loopholes may be successfully disputed by superior numbers, if you can get near enough to make pretty sure of firing in; the closer you are, too, the less you are also exposed to any direct fire from others.

When the bags were fixed, the fuzes would be lighted, and if the men could retire some 10 or 12 yards, close against the wall between any two loopholes, till the explosion took place, it would be safer than attempting to go back to the spot from whence they came. At this juncture,—the axemen,—the party with the ladders,—and one or both storming parties, should be perfectly prepared for springing forward. The moment the explosion takes place they should be up and away. The ladders would either be applied to the windows, as they would be in an escalade; or if the windows were low, they would be of service to form a kind of bridge for crossing the ditch, which might form the obstacle to getting in. A firing party would watch the opening and the adjacent loopholes, and the storming party would resolutely enter the moment the passage was ready, closely followed by the support, which would at the proper moment advance from its place of concealment.

With respect to the Attack on the Tambour, some little delay might be necessary, as the storming party could not enter till the inner door was forced. The axemen would therefore ply away till they had accomplished its destruction, during which time other men sent for the purpose might recreate in firing through the loopholes, to assist in clearing the passage. When the door was forced, the storming party would

advance, and by a vigorous charge through the opening, would overcome all opposition. The entrance gained, a momentary check to collect numbers might take place, and then a determined 'cast forward' in pursuit of the fugitives would be the right thing to do. If the defenders were of a sort 'not to be taken alive,' and were 'making play' for the upper story, where they would be more strongly posted, a sudden rush after them might afford the assailants the opportunity of accompanying them up stairs, and thus finish the affair at once. If the retreat were from one part of the house to another, they should be hotly pursued, without a moment for cogitation or taking breath, and they should be kept going till all opposition had ceased.

On the other hand, if the defenders had succeeded in gaining the upper floor, and the staircases were either destroyed, or too strongly barricaded to be carried by main force, a pretence at lighting a fire in the middle of the *dining-room* would not be without its effect; or any trifling preparations for making a mine in the angle of the *library*, if they did not fire down too much through the ceiling, so as to render it impracticable, would be as likely to bring them to terms as any measure which could be proposed.

If the lower part of a house were very stoutly barricaded, and the assailants were unprovided with bags of powder, for blowing the doors and windows open, an attempt might be made to silence the loopholes which bore on any particular point, and workmen might be employed there in forcing open an entrance, either at a door or window, or in breaking fairly through the wall itself. Or if ladders could be procured, an escalade of the upper windows, which are not usually so strongly fastened, might be attempted; but if denied access at these points, there is no just cause, though there might be impediments, why the roof should not be attacked. Ladders would be brought up and applied in the most convenient and covered situations that could be discovered, and if possible the assault should be made on several points at once. Having gained the roof, loopholes might be first knocked through at a single blow, and made use of for driving out the defenders,—these would soon be converted into great breaches;—a few grenades might take the duty of a firing party in clearing the front a little,—and an impetuous attack from this perhaps unexpected quarter would be likely enough to succeed.

If the subject of Attack were a church, a prison, or other large building, the same principles and precautions might be applied, only with this difference, that the offensive measures would be so arranged as to keep pace with the increased means of resistance.

B.

BAROMETER.—The only practical application of this instrument which is now offered, is in the determination of heights above the sea level. The memoranda respecting Observation, Registry, &c., are taken from the 'Report of the Committee on Physics and Meteorology, of the Royal Society,' 1840. For the form of Registry, vide 'Meteorology.'

The Tables computed by Mr. Howlett, in vol. i. of the Corps Papers, are those which are selected for Barometrical measurements: they are accompanied by the formulæ of Isaac Dalby,* and Sir G. Shuckburgh, as means of approximate check where verification may be desired.

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* Commonly called General Roy's formula.

Mr. Howlett's Tables.—In using these the column letters have been changed to obtain the advantage of significant initials to a greater extent. Under these circumstances, the rule given stands thus:

Log. difference of feet in altitude = log. R + Y + Z.

R being = log. b − (X + log. B.)

	Upper.	Lower.
Where Barometer is	B	b.
Attached thermometer . . .	A	a.
Detached thermometer . . .	D	d.

Also:

$$\left.\begin{array}{l} \Delta = A \backsim a \\ S = D + d \\ L = \text{latitude} \end{array}\right\} \text{and} \left\{\begin{array}{llll} X & \text{correspondent in} & \text{Table to} & \Delta. \\ Y & \text{,,} & \text{,,} & S. \\ Z & \text{,,} & \text{,,} & L. \end{array}\right.$$

Dalby, and Shuckburgh.

Dalby. Difference of altitude in fathoms

$$= \{10000\, l \mp \cdot 468\Delta\} \times \{1 + (M - 32^\circ) \times \cdot 00245\}$$

Shuckburgh. Do. $= \{10000\, l \mp \cdot 44\ \Delta\} \times \{1 + (M - 32^\circ) \times \cdot 00243\}$

The sign − is used where the attached thermometer is highest at the lower station.

,, + ,, ,, lowest ,,

In the above, $\left.\begin{array}{l} l = \log. b - \log. B \\ M = \dfrac{D + d}{2} \end{array}\right\}$ the other quantities being as before.

Example.

In lat. 51° 28′.

	Barometer.	Attached thermometer.	Detached thermometer.
Lower	29·862	68°	71°
Upper	26·137	63°	55°

1st. To find R.

Log. b (29·862) . . . . = 1·4751189

$$\left.\begin{array}{r} \text{Log. B (26·137)} \ldots = 1{\cdot}4172557 \\ 68^\circ - 63^\circ = 5^\circ;\ \text{and X to } 5^\circ = 0{\cdot}0002171 \\ \hline \text{X} + \text{log. B} = 1{\cdot}4174728 \end{array}\right\} = 1{\cdot}4174728$$

0·0576461 = R.

2ndly. Log. R (0·0576461) . . . = 8·7607315

Y (to D + d = 71° + 55° = 126°) = 4·8095776

Z to lat. 51° 28′ . . . . = 9·9997466

Log. diff. ft. in altitude . . = 3·5700557 = 3715·8 feet.

By Dalby's formula it is . . . . 3720 feet,

which gives a difference of only 4·2 feet,—a difference that is quite unimportant in ordinary operations: if greater nicety be required, the Barometer is hardly the instrument to be selected.

Table for determining Altitudes with the Barometer. Computed by Samuel B. Howlett, Chief Draftsman, Ordnance, from the formula given by F. Bailey, Esq.

Thermometers to the Barometers.			Thermometers in the open air.								Latitude of the place.	
	X		S	Y	S	Y	S	Y	S	Y	L	Z
Δ	Ther. highest at lowest station.	Ther. lowest at lowest station.										
			40°	4·7689067	75°	4·7859208	110°	4·8022936	145°	4·8180714	0°	0·0011689
			41	·7694021	76	·7863973	111	·8027525	146	·8185140	3	·0011624
			42	·7698971	77	·7868733	112	·8032109	147	·8189559	6	·0011433
0°	0·0000000	0·0000000	43	·7703911	78	·7873487	113	·8036687	148	·8193975	9	·0011117
1	·0000434	9·9999566	44	·7708851	79	·7878236	114	·8041261	149	·8198387	12	·0010679
2	·0000869	·9999131	45	·7713785	80	·7882979	115	·8045830	150	·8202794	15	·0010124
3	·0001303	·9998697	46	·7718711	81	·7887719	116	·8050395	151	·8207196	18	·0009459
4	·0001737	·9998262	47	·7723633	82	·7892451	117	·8054953	152	·8211594	21	·0008689
5	·0002171	·9997828	48	·7728548	83	·7897180	118	·8059509	153	·8215988	24	·0007825
6	·0002605	·9997393	49	·7733457	84	·7901903	119	·8064058	154	·8220377	27	·0006874
7	·0003039	·9996959	50	·7738363	85	·7906621	120	·8068604	155	·8224761	30	·0005848
8	·0003473	·9996524	51	·7743261	86	·7911335	121	·8073144	156	·8229141	33	·0004758
9	·0003907	·9996090	52	·7748153	87	·7916042	122	·8077680	157	·8233517	36	·0003615
10	·0004341	·9995655	53	·7753042	88	·7920745	123	·8082211	158	·8237888	39	·0002433
11	·0004775	·9995220	54	·7757925	89	·7925441	124	·8086737	159	·8242256	42	·0001223
12	·0005208	·9994785	55	·7762802	90	·7930135	125	·8091258	160	·8246618	45	·0000000
13	·0005642	·9994350	56	·7767674	91	·7934822	126	·8095776	161	·8250976	48	9·9998775
14	·0006076	·9993916	57	·7772540	92	·7939504	127	·8100287	162	·8255331	49	·9998372
15	·0006510	·9993481	58	·7777400	93	·7944182	128	·8104795	163	·8259680	50	·9997967
16	·0006943	·9993046	59	·7782256	94	·7948854	129	·8109298	164	·8264024	51	·9997566
17	·0007377	·9992611	60	·7787105	95	·7953521	130	·8113796	165	·8268365	52	·9997167
18	·0007810	·9992176	61	·7791949	96	·7958184	131	·8118290	166	·8272701	53	·9996772
19	·0008244	·9991741	62	·7796788	97	·7962841	132	·8122778	167	·8277034	54	·9996381
20	·0008677	·9991305	63	·7801622	98	·7967493	133	·8127263	168	·8281362	55	·9995995
21	·0009111	·9990870	64	·7806450	99	·7972141	134	·8131742	169	·8285685	56	·9995613
22	·0009544	·9990435	65	·7811272	100	·7976784	135	·8136216	170	·8290005	57	·9995237
23	·0009977	·9990000	66	·7816090	101	·7981421	136	·8140688	171	·8294319	58	·9994866
24	·0010411	·9989564	67	·7820902	102	·7986054	137	·8145153	172	·8298629	59	·9994502
25	·0010844	·9989129	68	·7825709	103	·7990681	138	·8149614	173	·8302937	60	·9994144
26	·0011277	·9988694	69	·7830511	104	·7995303	139	·8154070	174	·8307238	63	·9993115
27	·0011710	·9988258	70	·7835306	105	·7999921	140	·8158523	175	·8311536	66	·9992161
28	·0012143	·9987823	71	·7840098	106	·8004533	141	·8162970	176	·8315830	69	·9991293
29	·0012576	·9987387	72	·7844883	107	·8009142	142	·8167413	177	·8320119	75	·9989852
30	·0013009	·9986952	73	·7849664	108	·8013744	143	·8171852	178	·8324404	81	·9988854
31	·0013442	·9986516	74	·7854438	109	·8018343	144	·8176285	179	·8328686		

MEMORANDA FROM THE REPORT OF THE COMMITTEE ON PHYSICS AND METEOROLOGY, OF THE ROYAL SOCIETY, 1840.

Times of Observation.—The purposes of meteorological observations would be most perfectly and most expeditiously obtained by hourly observations throughout the year; but since in the case of private observers in general, and in few public establishments, such a course of unremitting labour cannot be hoped for, it is necessary, for general purposes, to select periods at longer intervals, calculated to embrace the extremes of the periodical oscillations to which the pressure of the atmosphere is subject, and to insure that uniformity of system at different stations on which the value of such observations so much depends. It is probable that the hours of 3 A. M., 9 A. M., 3 P. M., and 9 P. M., nearly coincide with the daily maxima and minima of the barometric column at the level of the sea, over a large portion of the globe; and it is desirable that as extensive a comparison as possible should be instituted at these hours. At the magnetic observatories it is provided that observations shall be made every second or even hour of Gottingen mean time throughout the twenty-four; so that there at least, and in all others which will act in concert and correspondence with them, the complete diurnal cycle will be satisfactorily observed. It would be uselessly superadding labour to the already extensive task imposed on these establishments, to require observations also at the hours above recommended for general

adoption as *meteorological* hours. They will, therefore, content themselves with filling up the forms furnished them, as adapted to the meteorological hours, with observations made at the nearest *magnetic* hours to those named at each station.

It is not, however, too much to expect that hourly observations should be made, during 24 hours, once in every month, by those who profess to pursue meteorology in a scientific manner; and when this cannot be effected, it is of the utmost importance that they should be made at least four times in the year, namely, at the summer and winter solstices, and at the spring and autumn equinoxes. One of the results of these hourly observations would probably be the indication of the exact times of the daily maxima and minima of pressure at different stations, which, if not found to coincide with the hours provisionally adopted, might ultimately be substituted for them under future directions. At the magnetic observatories the instruments will be read off hourly, on the days set apart in each month for the *magnetic term observations*, and the two-hourly system of observation in all cases continuing uninterrupted, will in effect furnish corresponding observations on all other days, whether arbitrarily chosen to suit private convenience, or in pursuance of the system about to be proposed in the subsequent paragraphs.

Hourly observations at the equinoxes and solstices have been already instituted at numerous points both of Europe and America, at the suggestion of Sir John Herschel, whose directions should be strictly attended to. They are as follows:

The days fixed upon for these observations are the 21st of March, the 21st of June, the 21st of September, and the 21st of December, being those, or immediately adjoining to those, of the equinoxes and solstices in which the solar influence is either stationary or in a state of most rapid variation. *But should any one of those 21st days fall on Sunday, then it will be understood that the observations are to be deferred till the next day, the 22nd.* The observation at each station should commence at 6 o'clock A. M. of the appointed days, and terminate at 6 A. M. of the days following, according to the usual reckoning of time at the place.

The commencement of each hour should be chosen, and every such series of observations accompanied by a notice of the means used to obtain the time, and, when practicable, by some observation of an astronomical nature by which the time can be ascertained within a minute or two.

The Committee now propose to extend these observations in regular series to the 21st of every month, with the same reservation with regard to Sundays.

Travellers provided with meteorological instruments who may be stationary on any of these days, may use them with advantage on such opportunities. Such as may ascend high mountains are recommended, *cæteris paribus*, to choose one of these days as affording a greater probability of securing a complete series of corresponding observations than any other; for which reason these observations cannot be too strongly recommended to *residents* in mountainous countries. The geologist, nay, even the surveyor, may find his account in traversing his field, Barometer in hand, on one of these days, provided he have reason to presume that there exist observers in its neighbourhood who take a part in these observations.

It is to be hoped that to scientific meteorological observers the six-hourly observations may not be found to be impracticable throughout the year; but in any case where it may be impossible to observe regularly at 3 A. M., an effort should be made to include the hour on the days of the new and full moon, and quadratures, or at least on the days of the new and full moon;—as it must be borne in mind, that in what concerns the great meteorological questions on which the most important features of the subject depend, the night is quite as important as the day, and has been hitherto far too much neglected.

Whatever hours, however, may be selected for the regular series of observations, the greatest care should be taken not to insert in the register any thing deduced by interpolation from observations made at other hours, or any thing, in short, but what has been actually observed.

It is much to be wished that occasional observations may be made under remarkable circumstances, such as during great rises or great falls of the Barometer, at the period of great storms, earthquakes, &c.; but such observations should be registered apart.

The Barometer should be placed in an apartment subject to as little variation of temperature as possible, and in a good light; and to facilitate night observations, an arrangement should be made for placing behind it a light screened by a sheet of white paper, or other diaphanous substance. Great care should be taken to fix it in a perpendicular position by the plumb-line. Its height must be carefully ascertained above some permanent and easily-recoverable mark, either in the building in which it is situated, or in some more permanent building, or rock in its immediate vicinity; and no pains should be spared to ascertain the relation which such mark may bear to the level of high and of low water at spring tides, and ultimately to the mean level of the sea.

Changes in the adjustments of meteorological instruments should be most carefully avoided; but whenever any alterations may be absolutely necessary, they should be made with all deliberation, scrupulously noticed in the register, and the exact amount of the change thence arising in the reading of the instrument under re-adjustment ascertained. As far as possible, registers of meteorological observations should be complete; but if, by unavoidable circumstances of absence, or from other causes, blanks occur, no attempts to fill them up by general recollection, or by the apparent course of the numbers before and after, should ever be made.

The observatories established by the Government are furnished with two Barometers each, of Newman's construction—the one a standard, and the other portable; and they are accompanied by accurate directions for fixing and observing them.

The standard instrument is of large dimensions, its tube being of the diameter of 0·6 inch. It requires two adjustments: 1st. The whole scale, which is of brass, is moveable, and terminates in an ivory point, which is carefully brought down to the surface of the mercury in the cistern, and the two are known to be accurately in contact when the actual point and its reflection appear just to touch one another. The scale is laid off from this point from an authentic standard, at the temperature of 32°.

2nd. The second adjustment is that of the vernier, in which the upper part of the scale terminates, to the surface of the mercury in the tube. For this, both the back and front edge are made to coincide, and brought down so as to form a tangent to the curve, and just to exclude the light between them at the point of contact. In making both these adjustments, it is desirable that the eye should be assisted by a magnifying glass. Before the observation is made, the instrument should be slightly tapped, to free the mercury from any adhesion to the glass; but any violent oscillation should be avoided.

The portable Barometer has only one adjustment, namely, that of the vernier to the upper surface of the mercury in the tube, which adjustment must be effected with the same precaution as in the case of the standard instrument.

This first reading may be entered in the column prepared for it in the register, and beside it the temperature of the mercury carefully read off from the thermometer which dips into the cistern.

As, in the case of the standard Barometer, the first measure is taken immediately

from the surface of the mercury in the cistern, it requires no correction for the different capacities of the tube and cistern. Neither does it require any correction for capillary action, as the large diameter of the tube renders this correction inappreciable.

The portable Barometer, however, requires corrections for both these circumstances. For the purpose of the former, the *neutral point* is marked upon each instrument, or that particular height which, in the construction of the instrument, has been actually measured from the surface of the mercury in the cistern.

It is obvious that, in almost every case, the mercury will stand either above or below the neutral point: if above, a portion of the mercury must have left the cistern to enter the tube, and consequently must have lowered the surface in the cistern; if below, a quantity of mercury must have left the tube, and, entering the cistern, raised the level of the mercury in it. For the correction of observations for this circumstance, the relation of the capacities of the tube and cistern have been experimentally ascertained, and are marked upon the instrument: thus *capacity* $\frac{1}{50}$th indicates that for every inch of elevation of the mercury in the tube, that in the cistern will be depressed one 50th of an inch. Thus, when the mercury in the tube is above the neutral point, the difference between it and the neutral point is to be divided by the capacity, and the quotient being added to the observed height, the result will be the corrected height. Or if the mercury at the time of observation should be below the neutral point, the difference of the two is to be divided as before, and the quotient to be subtracted from the observed height. Thus, suppose the capacity to be $\frac{1}{50}$th, the neutral point 30 inches, and the observed height 30·500 inches, the difference is 0·5 inch, which, divided by 50, gives 0·01 inch to be added to the observed height, producing 30·51, the corrected height; or if the observed height be 29 inches, the difference, 1 inch, divided by 50, gives ·02 inch to be subtracted from the observed height, giving 28·980 inches for the corrected height.

The second correction required is for the capillary action of the tube, the effect of which is constantly to depress the mercury in the tube by a certain quantity inversely proportioned to the diameter of the tube. In the instruments furnished to the fixed observatories the amount has been experimentally determined during their construction, and marked upon the instrument; the quantity is always to be added to the height of the mercurial column, previously corrected as before. For the convenience of those who may have Barometers, the capillary action of which has not been so determined, a Table of the corrections for tubes of different diameters is given.

The Marine Barometers differ in nothing from the other portable Barometers but in the mode of their suspension and the necessary contraction of the tubes to prevent oscillation from the motion of the ship, and require the same corrections.

When these two corrections have been made in the first reading of the portable Barometer, it should agree with the direct observation of the standard Barometer; and it is very desirable that frequent comparative observations should be made of the two instruments, in order to ascertain whether there may be any permanent difference between them. Should this be the case, the amount may be marked upon the instrument, and allowed for as an index error, in order that, if an accident should happen to one, the other may be substituted for it without detriment to the regular series of observations.

It is to be presumed that the portable Barometer will frequently be employed in ascertaining the altitude of remarkable points in the vicinity of the observatory.

The instruments furnished to the observatories have been all independently graduated and compared with the standard of the Royal Society; and in all cases it

is desirable that such a comparison should be made with some standard instrument of authority, directly, or by means of a good portable Barometer. In making such comparisons, all that is necessary is to record five or ten simultaneous readings of both instruments, deliberately made, at intervals of a few minutes from each other, after, at least, an hour's quiet exposure, side by side, that they may have the same temperature. If compared by two observers, each should read off his own Barometer in his usual manner, then each should verify the other's result. By this means the zero of one standard may be transported over all the world, and that of others compared with it ascertained. To do so, however, with perfect effect, requires the utmost care in the transport of the intermediate Barometer, and is by no means an operation either of trifling import or of hurried or negligent performance: some of the greatest questions in meteorology depend on its due execution.

The next correction, and, in some respects, the most important of all, is that due to the temperature of the mercury in the Barometer tube at the time of observation. To obtain this, every Barometer requires to have attached to it a Thermometer, which in the instruments furnished to the observatories dips into the mercury in the cistern, and this must be read and registered at each observation of the Barometer. A Table (II.) is appended, calculated by Professor Schumacher, which gives for every degree of the Thermometer and every half inch of the Barometer, the proper quantity to be added or subtracted for the reduction of the observed height to the standard temperature of 32° Fahrenheit.

It must, however, be observed, that this Table is only calculated for Barometers whose scales are engraven upon a rod or plate of brass reaching from the level of the mercury to the vernier. In many Barometers the scale is engraved upon a short plate of brass fixed upon the wooden frame of the instrument, and the compound expansion of the two substances can only be guessed at, but must be obviously less than if the whole length had been of brass. As a near approximation for such imperfect instruments, another Table (III.) has been given, in which the lesser expansion of glass has been substituted for that of brass. No scientific observer, however, would willingly use such an instrument.

Although all these corrections are necessary for the strict *reduction* of registered observations, they ought not to be applied to individual observations previously to registry. In the blank forms of register furnished to the observatories, one sheet is devoted to uncorrected observations, and a second to the corrected; and it is much to be wished that the proper reductions should be made as soon after the observations as possible.

TABLE I.

Correction to be added to Barometers for Capillary Action.

	Correction for	
Diameter of Tube.	Unboiled Tubes.	Boiled Tubes.
inch.	inch.	inch.
0·60	0·004	0·002
0·50	0·007	0·003
0·45	0·010	0·005
0·40	0·014	0·007
0·35	0·020	0·010
0·30	0·028	0·014
0·25	0·040	0·020
0·20	0·060	0·029
0·15	0·088	0·044
0·10	0·142	0·070

TABLE II.

Correction to be applied to Barometers with brass scales, *extending from the Cistern to the top of the Mercurial Column, to reduce the observation to* 32° *Fahrenheit.*

Temp.	Inches. 20	20·5	21	21·5	22	22·5	23	23·5
°	+	+	+	+	+	+	+	+
0	·051	·053	·054	·055	·056	·058	·059	·060
1	·049	·051	·052	·053	·054	·056	·057	·058
2	·048	·049	·050	·051	·052	·054	·055	·056
3	·046	·047	·048	·049	·050	·052	·053	·054
4	·044	·045	·046	·047	·048	·050	·051	·052
5	·042	·043	·044	·045	·046	·048	·049	·050
6	·040	·042	·042	·044	·044	·046	·047	·048
7	·039	·040	·041	·042	·042	·044	·044	·046
8	·037	·038	·039	·040	·041	·041	·042	·043
9	·035	·036	·037	·038	·039	·039	·040	·041
10	·033	·034	·035	·036	·037	·037	·038	·039
11	·031	·032	·033	·034	·035	·035	·036	·037
12	·030	·030	·031	·032	·033	·033	·034	·035
13	·028	·029	·029	·030	·031	·031	·032	·033
14	·026	·027	·027	·028	·029	·029	·030	·031
15	·024	·025	·026	·026	·027	·027	·028	·029
16	·022	·023	·024	·024	·025	·025	·026	·026
17	·021	·021	·022	·022	·023	·023	·024	·024
18	·019	·019	·020	·020	·021	·021	·022	·022
19	·017	·018	·018	·018	·019	·019	·020	·020
20	·015	·016	·016	·016	·017	·017	·018	·018
21	·014	·014	·014	·015	·015	·015	·015	·016
22	·012	·012	·012	·013	·013	·013	·013	·014
23	·010	·010	·010	·011	·011	·011	·011	·012
24	·008	·008	·009	·009	·009	·009	·009	·010
25	·006	·007	·007	·007	·007	·007	·007	·007
26	·005	·005	·005	·005	·005	·005	·005	·005
27	·003	·003	·003	·003	·003	·003	·003	·003
28	·001	·001	·001	·001	·001	·001	·001	·001
	—	—	—	—	—	—	—	—
29	·001	·001	·001	·001	·001	·001	·001	·001
30	·003	·003	·003	·003	·003	·003	·003	·003
31	·005	·005	·005	·005	·005	·005	·005	·005
32	·006	·006	·007	·007	·007	·007	·007	·007
33	·008	·008	·008	·009	·009	·009	·009	·010
34	·010	·010	·010	·011	·011	·011	·011	·012
35	·012	·012	·012	·013	·013	·013	·013	·014
36	·013	·014	·014	·014	·015	·015	·016	·016
37	·015	·016	·016	·016	·017	·017	·018	·018
38	·017	·017	·018	·018	·019	·019	·020	·020
39	·019	·019	·020	·020	·021	·021	·022	·022
40	·021	·021	·022	·022	·023	·023	·024	·024
41	·022	·023	·024	·024	·025	·025	·026	·026
42	·024	·025	·025	·026	·027	·027	·028	·028
43	·026	·027	·027	·028	·029	·029	·030	·031
44	·028	·029	·029	·030	·031	·031	·032	·033
45	·030	·030	·031	·032	·033	·033	·034	·035
46	·031	·032	·033	·034	·035	·035	·036	·037
47	·033	·034	·035	·036	·036	·037	·038	·039
48	·035	·036	·037	·038	·038	·039	·040	·041
49	·037	·038	·039	·040	·040	·041	·042	·043
59	·038	·039	·040	·041	·042	·043	·044	·045

Temp.	Inches. 20	20·5	21	21·5	22	22·5	23	23·5
°	—	—	—	—	—	—	—	—
51	·040	·041	·042	·043	·044	·045	·046	·047
52	·042	·043	·044	·045	·046	·047	·048	·049
53	·044	·045	·046	·047	·048	·049	·050	·052
54	·046	·047	·048	·049	·050	·051	·052	·054
55	.047	·049	·050	·051	·052	·053	·055	·056
56	·049	·050	·052	·053	·054	·055	·057	·058
57	·051	·052	·054	·055	·056	·057	·059	·060
58	·053	·054	·055	·057	·058	·059	·061	·062
59	·055	·056	·057	·059	·060	·061	·063	·064
60	·056	·058	·059	·061	·062	·063	·065	·066
61	·058	·060	·061	·062	·064	·065	·067	·068
62	·060	·061	·063	·064	·066	·067	·069	·070
63	·062	·063	·065	·066	·068	·069	·071	·072
64	·063	·065	·067	·068	·070	·071	·073	·075
65	·065	·067	·068	·070	·072	·073	·075	·077
66	·067	·069	·070	·072	·074	·075	·077	·079
67	·069	·071	·072	·074	·076	·077	·079	·081
68	·071	·072	·074	·076	·078	·079	·081	·083
69	·072	·074	·076	·078	·080	·081	·083	·085
70	·074	·076	·078	·080	·082	·083	·085	·087
71	·076	·078	·080	·082	·083	·085	·087	·089
72	·078	·080	·082	·084	·085	·087	·089	·091
73	·079	·081	·083	·085	·087	·089	·091	·093
74	·081	·083	·085	.087	·089	·091	·093	·095
75	·083	·085	·087	·089	·091	·093	·095	·098
76	·085	·087	·089	·091	·093	·095	·097	·100
77	·087	·089	·091	·093	·095	·097	·100	·102
78	·088	·091	·093	·095	·097	·099	·102	·104
79	·090	·092	·095	·097	·099	·101	·104	·106
80	·092	·094	·096	·099	·101	·103	·106	·108
81	·094	·096	·098	·101	·103	·105	·108	·110
82	·095	·098	·100	·103	·105	·107	·110	·112
83	·097	·100	·102	·104	·107	·109	·112	·114
84	·099	·101	·104	·106	·109	·111	·114	·116
85	·101	·103	·106	·108	·111	·113	·116	·118
86	·103	·105	·108	·110	·113	·115	·118	·120
87	·104	·107	·109	·112	·115	·117	·120	·123
88	·106	·109	·111	·114	·117	·119	·122	·125
89	·108	·111	·113	·116	·119	·121	·124	·127
90	·110	·112	·115	·118	·121	·123	·126	·129
91	·111	·114	·117	·120	·122	·125	·128	·131
92	·113	·116	·119	·122	·124	·127	·130	·133
93	·115	·118	·121	·124	·126	·129	·132	·135
94	·117	·120	·122	·125	·128	·131	·134	·137
95	·118	·121	·124	·127	·130	·133	·136	·139
96	·120	·123	·126	·129	·132	·135	·138	·141
97	·122	·125	·128	·131	·134	·137	·140	·143
98	·124	·127	·130	·133	·136	·139	·142	·145
99	·125	·129	·132	·135	·138	·141	·144	·147
100	·127	·130	·134	·137	·140	·143	·146	·150

is desirable that such a comparison should be made with some standard instrument of authority, directly, or by means of a good portable Barometer. In making such comparisons, all that is necessary is to record five or ten simultaneous readings of both instruments, deliberately made, at intervals of a few minutes from each other, after, at least, an hour's quiet exposure, side by side, that they may have the same temperature. If compared by two observers, each should read off his own Barometer in his usual manner, then each should verify the other's result. By this means the zero of one standard may be transported over all the world, and that of others compared with it ascertained. To do so, however, with perfect effect, requires the utmost care in the transport of the intermediate Barometer, and is by no means an operation either of trifling import or of hurried or negligent performance: some of the greatest questions in meteorology depend on its due execution.

The next correction, and, in some respects, the most important of all, is that due to the temperature of the mercury in the Barometer tube at the time of observation. To obtain this, every Barometer requires to have attached to it a Thermometer, which in the instruments furnished to the observatories dips into the mercury in the cistern, and this must be read and registered at each observation of the Barometer. A Table (II.) is appended, calculated by Professor Schumacher, which gives for every degree of the Thermometer and every half inch of the Barometer, the proper quantity to be added or subtracted for the reduction of the observed height to the standard temperature of 32° Fahrenheit.

It must, however, be observed, that this Table is only calculated for Barometers whose scales are engraven upon a rod or plate of brass reaching from the level of the mercury to the vernier. In many Barometers the scale is engraved upon a short plate of brass fixed upon the wooden frame of the instrument, and the compound expansion of the two substances can only be guessed at, but must be obviously less than if the whole length had been of brass. As a near approximation for such imperfect instruments, another Table (III.) has been given, in which the lesser expansion of glass has been substituted for that of brass. No scientific observer, however, would willingly use such an instrument.

Although all these corrections are necessary for the strict *reduction* of registered observations, they ought not to be applied to individual observations previously to registry. In the blank forms of register furnished to the observatories, one sheet is devoted to uncorrected observations, and a second to the corrected; and it is much to be wished that the proper reductions should be made as soon after the observations as possible.

TABLE I.

Correction to be added to Barometers for Capillary Action.

Diameter of Tube.	Correction for Unboiled Tubes.	Correction for Boiled Tubes.
inch.	inch.	inch.
0·60	0·004	0·002
0·50	0·007	0·003
0·45	0·010	0·005
0·40	0·014	0·007
0·35	0·020	0·010
0·30	0·028	0·014
0·25	0·040	0·020
0·20	0·060	0·029
0·15	0·088	0·044
0·10	0·142	0·070

TABLE II.

Correction to be applied to Barometers with brass scales, *extending from the Cistern to the top of the Mercurial Column, to reduce the observation to* 32° *Fahrenheit.*

Temp.	Inches.								Temp.	Inches.							
	20	20·5	21	21·5	22	22·5	23	23·5		20	20·5	21	21·5	22	22·5	23	23·5
°	+	+	+	+	+	+	+	+	°	—	—	—	—	—	—	—	—
0	·051	·053	·054	·055	·056	·058	·059	·060	51	·040	·041	·042	·043	·044	·045	·046	·047
1	·049	·051	·052	·053	·054	·056	·057	·058	52	·042	·043	·044	·045	·046	·047	·048	·049
2	·048	·049	·050	·051	·052	·054	·055	·056	53	·044	·045	·046	·047	·048	·049	·050	·052
3	·046	·047	·048	·049	·050	·052	·053	·054	54	·046	·047	·048	·049	·050	·051	·052	·054
4	·044	·045	·046	·047	·048	·050	·051	·052	55	.047	·049	·050	·051	·052	·053	·055	·056
5	·042	·043	·044	·045	·046	·048	·049	·050	56	·049	·050	·052	·053	·054	·055	·057	·058
6	·040	·042	·042	·044	·044	·046	·047	·048	57	·051	·052	·054	·055	·056	·057	·059	·060
7	·039	·040	·041	·042	·042	·044	·044	·046	58	·053	·054	·055	·057	·058	·059	·061	·062
8	·037	·038	·039	·040	·041	·041	·042	·043	59	·055	·056	·057	·059	·060	·061	·063	·064
9	·035	·036	·037	·038	·039	·039	·040	·041	60	·056	·058	·059	·061	·062	·063	·065	·066
10	·033	·034	·035	·036	·037	·037	·038	·039									
11	·031	·032	·033	·034	·035	·035	·036	·037	61	·058	·060	·061	·062	·064	·065	·067	·068
12	·030	·030	·031	·032	·033	·033	·034	·035	62	·060	·061	·063	·064	·066	·067	·069	·070
13	·028	·029	·029	·030	·031	·031	·032	·033	63	·062	·063	·065	·066	·068	·069	·071	·072
14	·026	·027	·027	·028	·029	·029	·030	·031	64	·063	·065	·067	·068	·070	·071	·073	·075
15	·024	·025	·026	·026	·027	·027	·028	·029	65	·065	·067	·068	·070	·072	·073	·075	·077
16	·022	·023	·024	·024	·025	·025	·026	·026	66	·067	·069	·070	·072	·074	·075	·077	·079
17	·021	·021	·022	·022	·023	·023	·024	·024	67	·069	·071	·072	·074	·076	·077	·079	·081
18	·019	·019	·020	·020	·021	·021	·022	·022	68	·071	·072	·074	·076	·078	·079	·081	·083
19	·017	·018	·018	·018	·019	·019	·020	·020	69	·072	·074	·076	·078	·080	·081	·083	·085
20	·015	·016	·016	·016	·017	·017	·018	·018	70	·074	·076	·078	·080	·082	·083	·085	·087
21	·014	·014	·014	·015	·015	·015	·015	·016	71	·076	·078	·080	·082	·083	·085	·087	·089
22	·012	·012	·012	·013	·013	·013	·013	·014	72	·078	·080	·082	·084	·085	·087	·089	·091
23	·010	·010	·010	·011	·011	·011	·011	·012	73	·079	·081	·083	·085	·087	·089	·091	·093
24	·008	·008	·009	·009	·009	·009	·009	·010	74	·081	·083	·085	.087	·089	·091	·093	·095
25	·006	·007	·007	·007	·007	·007	·007	·007	75	·083	·085	·087	·089	·091	·093	·095	·098
26	·005	·005	·005	·005	·005	·005	·005	·005	76	·085	·087	·089	·091	·093	·095	·097	·100
27	·003	·003	·003	·003	·003	·003	·003	·003	77	·087	·089	·091	·093	·095	·097	·100	·102
28	·001	·001	·001	·001	·001	·001	·001	·001	78	·088	·091	·093	·095	·097	·099	·102	·104
	—	—	—	—	—	—	—	—	79	·090	·092	·095	·097	·099	·101	·104	·106
29	·001	·001	·001	·001	·001	·001	·001	·001	80	·092	·094	·096	·099	·101	·103	·106	·108
30	·003	·003	·003	·003	·003	·003	·003	·003									
31	·005	·005	·005	·005	·005	·005	·005	·005	81	·094	·096	·098	·101	·103	·105	·108	·110
32	·006	·006	·007	·007	·007	·007	·007	·007	82	·095	·098	·100	·103	·105	·107	·110	·112
33	·008	·008	·008	·009	·009	·009	·009	·010	83	·097	·100	·102	·104	·107	·109	·112	·114
34	·010	·010	·010	·011	·011	·011	·011	·012	84	·099	·101	·104	·106	·109	·111	·114	·116
35	·012	·012	·012	·013	·013	·013	·013	·014	85	·101	·103	·106	·108	·111	·113	·116	·118
36	·013	·014	·014	·014	·015	·015	·016	·016	86	·103	·105	·108	·110	·113	·115	·118	·120
37	·015	·016	·016	·016	·017	·017	·018	·018	87	·104	·107	·109	·112	·115	·117	·120	·123
38	·017	·017	·018	·018	·019	·019	·020	·020	88	·106	·109	·111	·114	·117	·119	·122	·125
39	·019	·019	·020	·020	·021	·021	·022	·022	89	·108	·111	·113	·116	·119	·121	·124	·127
40	·021	·021	·022	·022	·023	·023	·024	·024	90	·110	·112	·115	·118	·121	·123	·126	·129
41	·022	·023	·024	·024	·025	·025	·026	·026	91	·111	·114	·117	·120	·122	·125	·128	·131
42	·024	·025	·025	·026	·027	·027	·028	·028	92	·113	·116	·119	·122	·124	·127	·130	·133
43	·026	·027	·027	·028	·029	·029	·030	·031	93	·115	·118	·121	·124	·126	·129	·132	·135
44	·028	·029	·029	·030	·031	·031	·032	·033	94	·117	·120	·122	·125	·128	·131	·134	·137
45	·030	·030	·031	·032	·033	·033	·034	·035	95	·118	·121	·124	·127	·130	·133	·136	·139
46	·031	·032	·033	·034	·035	·035	·036	·037	96	·120	·123	·126	·129	·132	·135	·138	·141
47	·033	·034	·035	·036	·036	·037	·038	·039	97	·122	·125	·128	·131	·134	·137	·140	·143
48	·035	·036	·037	·038	·038	·039	·040	·041	98	·124	·127	·130	·133	·136	·139	·142	·145
49	·037	·038	·039	·040	·040	·041	·042	·043	99	·125	·129	·132	·135	·138	·141	·144	·147
50	·038	·039	·040	·041	·042	·043	·044	·045	100	·127	·130	·134	·137	·140	·143	·146	·150

TABLE II.—*Continued.*

Temp.	Inches. 24	24·5	25	25·5	26	26·5	27	27·5	Temp.
°	+	+	+	+	+	+	+	+	°
0	·061	·063	·064	·065	·067	·068	·069	·071	0
1	·059	·061	·062	·063	·064	·065	·067	·068	1
2	·057	·058	·060	·061	·062	·063	·064	·066	2
3	·055	·056	·057	·059	·060	·061	·062	·063	3
4	·053	·054	·055	·056	·057	·058	·059	·061	4
5	·051	·052	·053	·054	·055	·056	·057	·558	5
6	·049	·050	·051	·052	·053	·054	·055	·056	6
7	·046	·047	·048	·049	·050	·051	·052	·053	7
8	·044	·045	·046	·047	·048	·049	·050	·051	8
9	·042	·043	·044	·045	·046	·046	·047	·048	9
10	·040	·041	·042	·042	·043	·044	·045	·046	10
11	·038	·039	·039	·040	·041	·042	·042	·043	11
12	·036	·036	·037	·038	·039	·039	·040	·041	12
13	·033	·034	·035	·036	·036	·037	·038	·038	13
14	·031	·032	·033	·033	·034	·035	·035	·036	14
15	·029	·030	·030	·031	·032	·032	·033	·033	15
16	·027	·028	·028	·029	·029	·030	·030	·031	16
17	·025	·025	·026	·026	·027	·027	·028	·028	17
18	·023	·023	·024	·024	·025	·025	·025	·026	18
19	·021	·021	·021	·022	·022	·023	·023	·024	19
20	·018	·019	·019	·020	·020	·020	·021	·021	20
21	·016	·017	·017	·017	·018	·018	·018	·019	21
22	·014	·014	·015	·015	·015	·016	·016	·016	22
23	·012	·012	·012	·013	·013	·013	·013	·014	23
24	·010	·010	·010	·010	·011	·011	·011	·011	24
25	·008	·008	·008	·008	·008	·008	·009	·009	25
26	·005	·006	·006	·006	·006	·006	·006	·006	26
27	·003	·003	·003	·003	·004	·004	·004	·004	27
28	·001	·001	·001	·001	·001	·001	·001	·001	28
	—	—	—	—	—	—	—	—	
29	·001	·001	·001	·001	·001	·001	·001	·001	29
30	·003	·003	·003	·004	·004	·004	·004	·004	30
31	·005	·006	·006	·006	·006	·006	·006	·006	31
32	·008	·008	·008	·008	·008	·008	·008	·009	32
33	·010	·010	·010	·010	·011	·011	·011	·011	33
34	·012	·012	·012	·013	·013	·013	·013	·014	34
35	·014	·014	·015	·015	·015	·015	·016	·016	35
36	·016	·017	·017	·017	·017	·018	·018	·019	36
37	·018	·019	·019	·019	·020	·020	·021	·021	37
38	·020	·021	·021	·022	·022	·023	·023	·023	38
39	·023	·023	·024	·024	·024	·025	·025	·026	39
40	·025	·025	·026	·026	·027	·027	·028	·028	40
41	·027	·027	·028	·029	·029	·030	·030	·031	41
42	·029	·030	·030	·031	·031	·032	·033	·033	42
43	·031	·032	·032	·033	·034	·034	·035	·036	43
44	·033	·034	·035	·035	·036	·037	·037	·038	44
45	·035	·036	·037	·038	·038	·039	·040	·041	45
46	·038	·038	·039	·040	·041	·042	·042	·043	46
47	·040	·041	·041	·042	·043	·044	·045	·046	47
48	·042	·043	·044	·045	·045	·046	·047	·048	48
49	·044	·045	·046	·047	·048	·049	·050	·050	49
50	·046	·047	·048	·049	·050	·051	·052	·053	50

Temp.	Inches. 24	24·5	25	25·5	26	26·5	27	27·5	Temp.
°	—	—	—	—	—	—	—	—	°
51	·048	·049	·050	·051	·052	·053	·054	·055	51
52	·050	·052	·053	·054	·055	·056	·057	·058	52
53	·053	·054	·055	·056	·057	·058	·059	·060	53
54	·055	·056	·057	·058	·059	·060	·062	·063	54
55	·057	·058	·059	·060	·062	·063	·064	·065	55
56	·059	·060	·061	·063	·064	·065	·066	·068	56
57	·061	·062	·064	·065	·066	·068	·069	·070	57
58	·063	·065	·066	·067	·069	·070	·071	·073	58
59	·065	·067	·068	·070	·071	·072	·074	·075	59
60	·068	·069	·070	·072	·073	·075	·076	·077	60
61	·070	·071	·073	·074	·075	·077	·078	·080	61
62	·072	·073	·075	·076	·078	·079	·081	·082	62
63	·074	·076	·077	·079	·080	·082	·083	·085	63
64	·076	·078	·079	·081	·082	·084	·086	·087	64
65	·078	·080	·082	·083	·085	·086	·088	·090	65
66	·080	·082	·084	·085	·087	·089	·090	·092	66
67	·083	·084	·086	·088	·089	·091	·093	·095	67
68	·085	·086	·088	·090	·092	·094	·095	·097	68
69	·087	·089	·090	·092	·094	·096	·098	·100	69
70	·089	·091	·093	·095	·096	·098	·100	·102	70
71	·091	·093	·095	·097	·099	·101	·102	·104	71
72	·093	·095	·097	·099	·101	·103	·105	·107	72
73	·095	·097	·099	·101	·103	·105	·107	·109	73
74	·097	·099	·102	·104	·106	·108	·110	·112	74
75	·100	·102	·104	·106	·108	·110	·112	·114	75
76	·102	·104	·106	·108	·110	·112	·114	·117	76
77	·104	·106	·108	·110	·112	·115	·117	·119	77
78	·106	·108	·110	·113	·115	·117	·119	·122	78
79	·108	·110	·113	·115	·117	·119	·122	·124	79
80	·110	·113	·115	·117	·119	·122	·124	·126	80
81	·112	·115	·117	·119	·122	·124	·126	·129	81
82	·114	·117	·119	·122	·124	·126	·129	·131	82
83	·117	·119	·121	·124	·126	·129	·131	·134	83
84	·119	·121	·124	·126	·129	·131	·134	·136	84
85	·121	·123	·126	·128	·131	·133	·136	·139	85
86	·123	·126	·128	·131	·133	·136	·138	·141	86
87	·125	·128	·130	·133	·136	·138	·141	·143	87
88	·127	·130	·133	·135	·138	·141	·143	·146	88
89	·129	·132	·135	·137	·140	·143	·146	·148	89
90	·131	·134	·137	·140	·142	·145	·148	·151	90
91	·134	·136	·139	·142	·145	·148	·150	·153	91
92	·136	·139	·141	·144	·147	·150	·153	·156	92
93	·138	·141	·144	·147	·149	·152	·155	·158	93
94	·140	·143	·146	·149	·152	·155	·157	·161	94
95	·142	·145	·148	·151	·154	·157	·160	·163	95
96	·144	·147	·150	·153	·156	·159	·162	·165	96
97	·146	·149	·152	·156	·159	·162	·165	·168	97
98	·148	·152	·155	·158	·161	·164	·167	·170	98
99	·151	·154	·157	·160	·163	·166	·169	·173	99
100	·153	·156	·159	·162	·165	·169	·172	·175	100

Temp.	Inches. 28	28·5	29	29·5	30	30·5	31	Temp.
°	+	+	+	+	+	+	+	°
0	·072	·073	·074	·076	·077	·078	·080	0
1	·069	·071	·072	·073	·074	·076	·077	1
2	·067	·068	·069	·070	·072	·073	·074	2
3	·064	·065	·067	·068	·069	·070	·071	3
4	·062	·063	·064	·065	·066	·067	·068	4
5	·059	·060	·061	·062	·063	·065	·066	5
6	·057	·058	·059	·060	·061	·062	·063	6
7	·054	·055	·056	·057	·058	·059	·060	7
8	·052	·053	·054	·054	·055	·056	·057	8
9	·049	·050	·051	·052	·053	·054	·054	9
10	·047	·047	·048	·049	·050	·051	·052	10
11	·044	·045	·046	·046	·047	·048	·049	11
12	·042	·042	·043	·044	·045	·045	·046	12
13	·039	·040	·040	·041	·042	·043	·043	13
14	·037	·037	·038	·038	·039	·040	·040	14
15	·034	·035	·035	·036	·036	·037	·038	15
16	·032	·032	·033	·033	·034	·034	·035	16
17	·029	·030	·030	·031	·031	·032	·032	17
18	·026	·027	·027	·028	·028	·029	·029	18
19	·024	·024	·025	·025	·026	·026	·027	19
20	·021	·022	·022	·023	·023	·023	·024	20
21	·019	·019	·020	·020	·020	·021	·021	21
22	·016	·017	·017	·017	·018	·018	·018	22
23	·014	·014	·014	·015	·015	·015	·015	23
24	·011	·012	·012	·012	·012	·012	·013	24
25	·009	·009	·009	·009	·009	·010	·010	25
26	·006	·006	·007	·007	·007	·007	·007	26
27	·004	·004	·004	·004	·004	·004	·004	27
28	·001	·001	·001	·001	·001	·001	·001	28
	—	—	—	—	—	—	—	
29	·001	·001	·001	·001	·001	·001	·001	29
30	·004	·004	·004	·004	·004	·004	·004	30
31	·006	·006	·007	·007	·007	·007	·007	31
32	·009	·009	·009	·009	·009	·010	·010	32
33	·011	·012	·012	·012	·012	·012	·012	33
34	·014	·014	·014	·015	·015	·015	·015	34
35	·016	·017	·017	·017	·018	·018	·018	35
36	·019	·019	·020	·020	·020	·021	·021	36
37	·021	·022	·022	·022	·023	·023	·024	37
38	·024	·024	·025	·025	·026	·026	·026	38
39	·026	·027	·027	·028	·028	·029	·029	39
40	·029	·029	·030	·030	·031	·031	·032	40
41	·031	·032	·033	·033	·034	·034	·035	41
42	·034	·034	·035	·036	·036	·037	·037	42
43	·036	·037	·038	·038	·039	·040	·040	43
44	·039	·040	·040	·041	·042	·042	·043	44
45	·041	·042	·043	·044	·044	·045	·046	45
46	·044	·045	·045	·046	·047	·048	·049	46
47	·046	·047	·048	·049	·050	·051	·051	47
48	·049	·050	·051	·052	·052	·053	·054	48
49	·051	·052	·053	·054	·055	·056	·057	49
50	·054	·055	·056	·057	·058	·059	·060	50

Temp.	Inches. 28	28·5	29	29·5	30	30·5	31	Temp.
°	—	—	—	—	—	—	—	°
51	·056	·057	·058	·059	·060	·061	·062	51
52	·059	·060	·061	·062	·063	·064	·065	52
53	·061	·063	·064	·065	·066	·067	·068	53
54	·064	·065	·066	·067	·068	·070	·071	54
55	·066	·068	·069	·070	·071	·072	·073	55
56	·069	·070	·071	·073	·074	·075	·076	56
57	·071	·073	·074	·075	·076	·078	·079	57
58	·074	·075	·077	·078	·079	·081	·082	58
59	·076	·078	·079	·080	·082	·083	·085	59
60	·079	·080	·082	·083	·085	·086	·087	60
61	·081	·083	·084	·086	·087	·089	·090	61
62	·084	·085	·087	·088	·090	·091	·093	62
63	·086	·088	·089	·091	·093	·094	·096	63
64	·089	·090	·092	·094	·095	·097	·098	64
65	·091	·093	·095	·096	·098	·100	·101	65
66	·094	·096	·097	·099	·101	·102	·104	66
67	·096	·098	·100	·102	·103	·105	·107	67
68	·099	·101	·102	·104	·106	·108	·109	68
69	·101	·103	·105	·107	·109	·110	·112	69
70	·104	·106	·108	·109	·111	·113	·115	70
71	·106	·108	·110	·112	·114	·116	·118	71
72	·109	·111	·113	·115	·117	·119	·120	72
73	·111	·113	·115	·117	·119	·121	·123	73
74	·114	·116	·118	·120	·122	·124	·126	74
75	·116	·118	·120	·122	·125	·127	·129	75
76	·119	·121	·123	·125	·127	·129	·131	76
77	·121	·123	·126	·128	·130	·132	·134	77
78	·124	·126	·128	·130	·133	·135	·137	78
79	·126	·128	·131	·133	·135	·137	·140	79
80	·129	·131	·133	·136	·138	·140	·143	80
81	·131	·134	·136	·138	·141	·143	·145	81
82	·134	·136	·138	·141	·143	·146	·148	82
83	·136	·139	·141	·143	·146	·148	·151	83
84	·139	·141	·144	·146	·149	·151	·154	84
85	·141	·144	·146	·149	·151	·154	·156	85
86	·144	·146	·149	·151	·154	·156	·159	86
87	·146	·149	·151	·154	·157	·159	·162	87
88	·149	·151	·154	·157	·159	·162	·165	88
89	·151	·154	·156	·159	·162	·165	·167	89
90	·153	·156	·159	·162	·164	·167	·170	90
91	·156	·159	·162	·165	·167	·170	·173	91
92	·158	·161	·164	·167	·170	·172	·175	92
93	·161	·164	·167	·170	·172	·175	·178	93
94	·163	·166	·169	·172	·175	·177	·180	94
95	·166	·169	·172	·175	·178	·180	·183	95
96	·168	·171	·174	·178	·181	·183	·186	96
97	·171	·174	·177	·180	·183	·186	·189	97
98	·173	·176	·179	·183	·186	·188	·191	98
99	·176	·179	·182	·185	·188	·191	·194	99
100	·178	·181	·184	·188	·191	·194	·197	100

TABLE III.

Correction to be applied to Barometers, the scales of which are engraven on glass, *to reduce the observations to* 32° *Fahrenheit.*

Temp.	Inches. 28·0	Inches. 28·5	Inches. 29·0	Inches. 29·5	Inches. 30·0	Inches. 30·5	Inches. 31·0	Inches. 31·5
25	+·017	+·017	+·017	+·018	+·018	+·018	+·019	+·019
30	+·005	+·005	+·005	+·005	+·005	+·005	+·005	+·005
35	−·007	−·007	−·007	−·008	−·008	−·008	−·008	−·008
40	−·019	−·020	−·020	−·020	−·021	−·021	−·021	−·022
45	−·031	−·032	−·032	−·033	−·033	−·034	−·035	−·036
50	−·043	−·044	−·045	−·046	−·046	−·047	−·048	−·049
55	−·055	−·056	−·057	−·058	−·059	−·060	−·061	−·062
60	−·067	−·068	−·069	−·071	−·072	−·074	−·075	−·076
65	−·079	−·081	−·082	−·083	−·085	−·086	−·088	−·089
70	−·091	−·093	−·094	−·096	−·098	−·100	−·101	−·103
75	−·103	−·105	−·106	−·109	−·111	−·114	−·116	−·118

R. J. N.

BARREL.—*Vide* 'Bridge,' Cask.

BARRICADE—considered as a *temporary* obstruction to attack; from the occupation of buildings converted into strong defensible posts, in the field,—to the hasty arrangements against insurrectionary movements in towns.

Reserving the former for its more appropriate heading, 'Defence of Posts,' reference will now only be made to the latter, and in the original sense of 'Barricade,' as derived from 'Barrique,' in allusion to the defences of the streets of Paris during the disturbances of the League, &c.

The character of the expected attack will determine the most general arrangement for the Barricade. If from the town, or country, only, the line of defence will be single; if from both, the points to be defended must be considered accordingly; not so much by double lines, as by being ready, front and rear, at those points.

In barricading a town, in whole, or part, it should be considered as *a position;* and every attention paid to the control of communications, to the stock of ammunition and provisions, and to the reduction of the space to be enclosed to the smallest advisable limits, so as to economize time, materials, and forces necessary for the more passive sort of defence, leaving as many as may be for that of an active character.

In all cases, the general maxim for field defences, of never leaving obstacles unsupported, must be borne in mind; especially, as in streets, where it may not be always possible to man the barriers, owing to the fire of the neighbouring houses, and when they can only be held by occupying the contiguous and flanking dwellings.

BARRICADING IN TOWNS.

The Barricade may consist of moveable portions of palisading, (figs. 1, 2,) made musket-proof by sand-bags. In some recent arrangements for defence, in Ireland, the following was the detail:

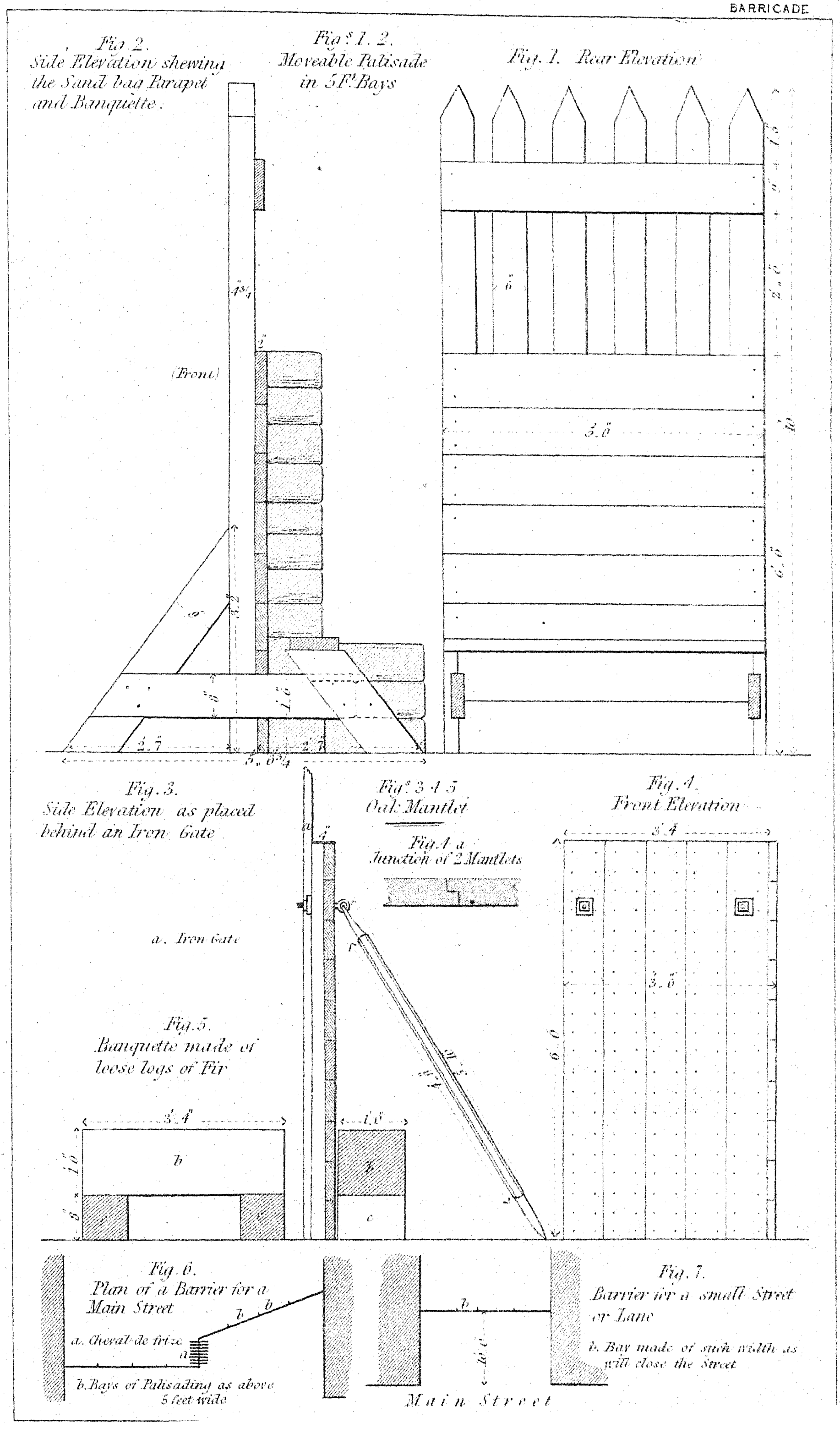
Fig. 2.
Side Elevation shewing the Sand bag Parapet and Banquette.
Figs. 1. 2.
Moveable Palisade in 5 Ft. Bays
Fig. 1. Rear Elevation
(Front)
Fig. 3.
Side Elevation as placed behind an Iron Gate
a. Iron Gate
Figs. 3. 4. 5
Oak Mantlet
Fig. 4. a
Junction of 2 Mantlets
Fig. 4.
Front Elevation
Fig. 5.
Banquette made of loose logs of Fir
Fig. 6.
Plan of a Barrier for a Main Street
a. Cheval de frize
b. Bays of Palisading as above 5 feet wide
Fig. 7.
Barrier for a small Street or Lane
b. Bay made of such width as will close the Street
Main Street

Per 5 ft. width of Street.

1 Bay of palisading, 5 ft. wide.
70 Bushel sand-bags, filled.
1 Mallet, hand.
1 Block, wood, 12″ × 6″ × 3″ } to rectify any unevenness in the streets.
1 Wedge, do. 12″ × 3″ }
1 Hand hatchet.
1 Sapper, 4 of the Line.
1 large cart, to contain the above materials.

Per Barrier.

1 Crow-bar.
1 Sledge hammer.
1 Felling-axe.
1 Pioneer.

Figs. 6 and 7 shew the mode in which these bays should be arranged.

Chevaux-de-frize were required, as at *a*, fig. 6, for barriers to those streets where thoroughfare was to be permitted; or in front of the parapets of sand-bags, with which blind alleys, or other suspicious openings, were to be closed.

In fig. 7, a recess of about 10 ft. is allowed, not to interfere with passengers, or be interrupted by them.

The above cannot in general be managed without some warning, as the equipment requires an amount of labour, material, and transport, not easily commanded; since each 5-ft. bay of palisading weighs about 450 lbs., and measures upwards of 20 cubic feet in transport. The following series of Barricade afford means of closing openings in various ways, most of them practicable under all circumstances.

1. Palisading; moveable, as above, or fixed, as usual.

2. Stockade* of trees; from esplanades, avenues, canals, gardens, &c. } loopholed; the bottom of the loophole not less than 8 feet above the ground outside.

3. Stockade of squared baulk; from the timber yards. }

4. Abattis; with, or without, parapet of earth and ditch, behind.

5. Parapet of baulk, or of logs roughly trimmed,—provided they go across the road, and either go into the walls, or can be well secured to them.

6. Barrels, hampers, or sacks filled with earth, as a parapet; a ditch in front; avoiding parapets of paving-stones as much as possible.

7. Earthen parapets, with plank revetments, supported by posts.

8. Carts, waggons, &c., jammed and lashed together.

9. Iron railing, removed bodily in convenient lengths, from enclosure walls, areas, &c.

10. Chevaux-de-frize; this, only occasionally, for particular points; especially for closing passages in the main Barricades, as a sort of temporary gate.

11. Sand-bag parapets,—with chevaux-de-frize in front, and loopholed above: this also is only an occasional resource.

&c., &c., &c.

Open iron gates are best rendered proof by oaken mantlets. See figs. 3, 4, 5.

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* Vide 'Stockade.'

The following thicknesses of ordinary materials, as determined by recent experiments,—

Walls,
- Brick, 1 brick thick,
- Granite, / Compact Limestone / Ditto Sandstone } 6 inches, solid stone,
- Cob (clay and straw) 9 inches thick,

Width of 1-bushel sand-bag, at least 10 inches, full of earth,

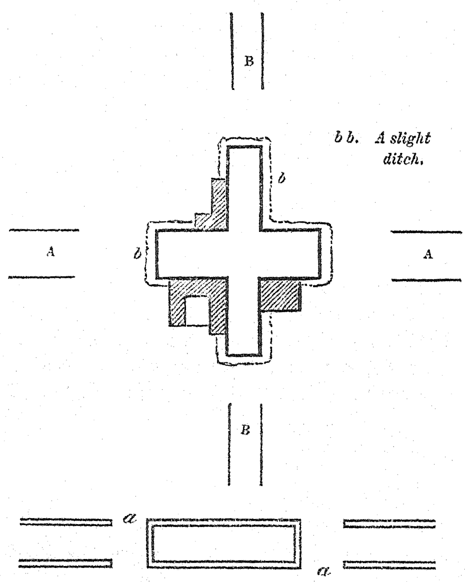
*12	inches thick,—	White pine,
* 9	do.	Yellow do.
* 4	do.	Oak, good,
2	do.	Oak, sheeted with $\frac{1}{8}$-inch wrought iron,†
$\frac{3}{8}$	do.	Sheet iron,

are the lowest that should be relied on as musket-proof.

BARRICADING ON THE OUTSKIRTS OF TOWNS.

As Insurgents are seldom burthened by artillery or baggage, they are not compelled to keep to the roads, where they would be most exposed; they will be apt to disperse over the fields: hence all hedges, or walls, parallel to the front of attack, or any thing else that may give cover, should be removed.

Where two tolerably wide roads, AA, BB, cross, they can generally be cut off so as to form a very fairly flanked redoubt, forbidding all advance along the roads themselves; the houses serving as barracks, and often capable of being loopholed.



If no crossings present themselves, any block of wide road, with an ordinary hedge,

* These thicknesses are best made up of different courses of plank crossing alternately, as in figs. 3, 4, 5, where the 4-inch oak is made up of two 2-inch planks.

† When oak is to be thus covered, a sheet of tarred brown paper should be placed between it and the metal, as the latter is likely to be corroded by the juices of the wood.

Rear Elevation of a Barrier Gate giving 10 ft. effective opening. — For 7'. 6" Palisading.

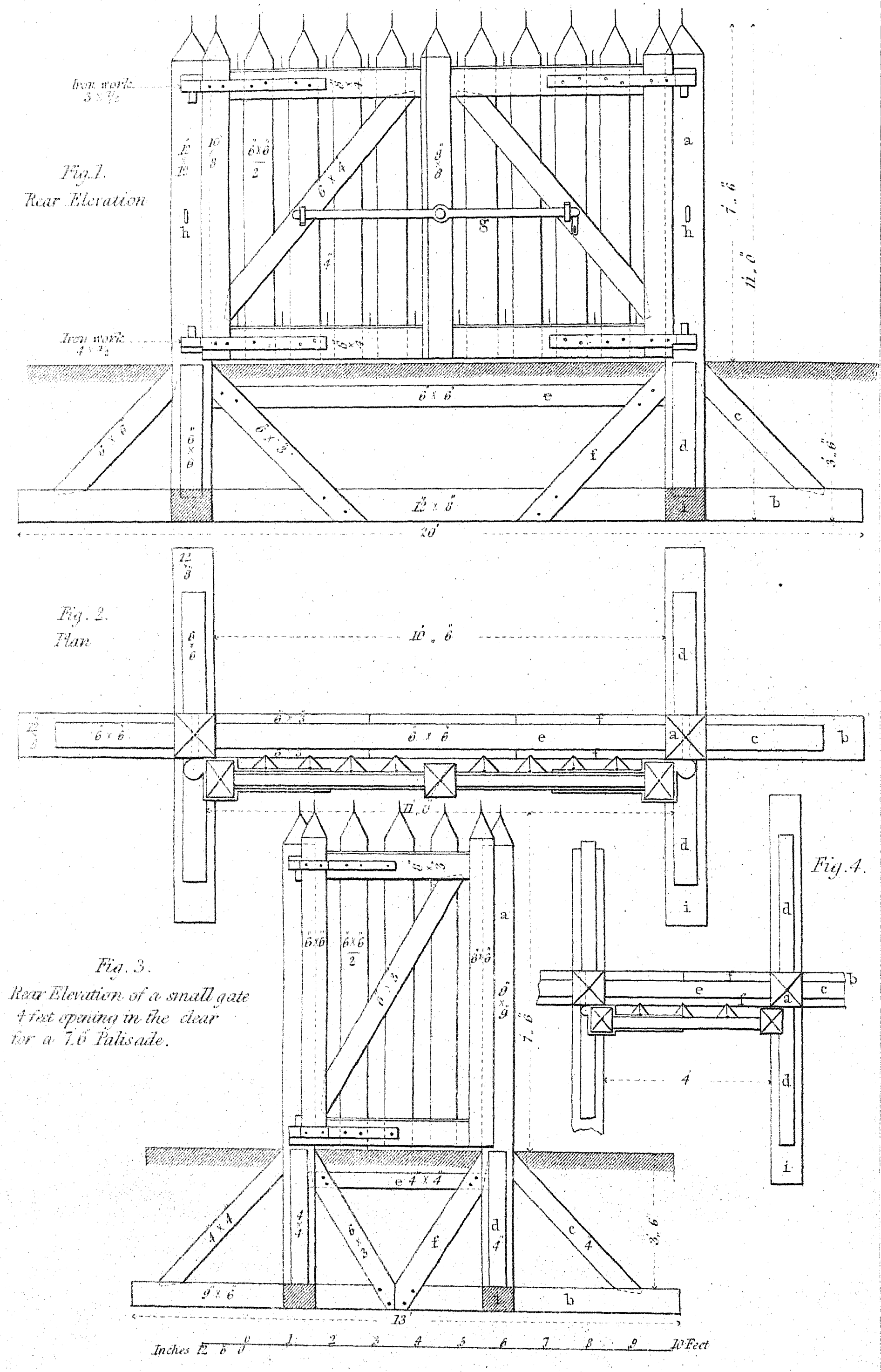


Fig. 1. Rear Elevation

Fig. 2. Plan

Fig. 3. Rear Elevation of a small gate 4 feet opening in the clear for a 7'. 6" Palisade.

Fig. 4.

has only to be closed at the end or ends, by moving up the portions *a*, *a*, and a respectable 'Barrier' may still be obtained. This and the preceding are particularly suitable to the case where provision has to be made to front and rear.

Nearly all the expedients given for Barricades in the towns are more or less applicable to suburbs, and the immediately adjacent outskirts; but it is highly unadvisable, in most instances, to lose sight of the principle of concentration by this extended occupation. In addition to this list of expedients for towns, in the country, or in villages, &c., we have field-gates, and often hurdles; both excellent in forming revetments and earthen parapets.

R. J. N.

BARRIER—as distinct from 'Barricade,' and considered only in relation to Fortification.

The purpose regulates the construction. If the Barrier is to be permanently defensible, it should be musket-proof, and then becomes a Stockade.—Vide 'Stockade.'

If occasionally defensible, or else simply obstructive, palisading will suffice, with a sand-bag or other temporary parapet when required, behind, and near enough to fire between the palisades.—Vide 'Palisades.'

The gates in both the above should if possible be of palisading, as the heavy stockade gate is unwieldly. If its being musket-proof is indispensable, 2-inch oak plank, covered with $\frac{1}{8}$-inch sheet iron, will be lighter and more effective,—*if* such materials can be procured.

Here the subject cannot be pursued farther without intrenching on 'Gate;' but as the higher class of field-works require such provision, the construction of a Barrier Gate is given in the Plate.

To regulate the width of the opening, 10 feet effective is assumed for waggons, carts, &c., of any size, as sufficient for a two-leaved gate. The one-leaved gate is given at 4 feet, as enough for a single horseman, or infantry two deep. A slight change must be made in fig. 1, if it is to be framed to admit of a wicket.

In the diagrams given, especially figs. 1, 2, the framing and scantling have been so regulated as to give abundant stability and strength to the whole, particularly the main posts *a*, without shewing the struts *c*, *d*, *f*, above ground, where they are not only in the way, but more likely to decay, especially where they enter the earth. If the level of the sleeper, *b*, admits of drainage, the whole should be laid and rammed tight with dry rubble, to allow the water to run freely off.

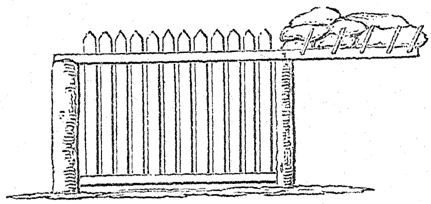
The gates themselves are so hung as to fall back clear of the opening; the hinges are kept entirely to the rear, and the upper ones are inverted. The heel-posts and meeting-stiles are allowed a sufficient thickness for the rails to enter without reduction as tenons: these rails are guarded by a strap of iron $2'' \times \frac{1}{4}''$ along the upper edge, to prevent their being readily cut through with an axe. The palisades are $6'' \times 6''$ scantling cut arris-wise, and $4''$ apart: if much more, it would be possible for a thin person to work through.

The bar, *g*, is given as merely an ordinary security: if more be required, a strong chain and padlock, between two stout staples of $\frac{1}{2}$-inch iron, will answer all purposes conveniently.

Barrier Gates should never be left unprotected.

When there is not time to construct such gates as are given in the Plate, the

following figure gives a tolerable substitute, and one that can be readily put together.



R. J. N.

BATTERY.—The framing of this Article is partly from Notes of Major-General Sir John Burgoyne; from some of the best authorities; and from reminiscences of the Compiler when in the Field.

Preliminary Remarks.—A Battery consists of two or more pieces of Artillery united for the purpose of dispersing troops, or destroying that which covers and protects them. The term Battery also implies the emplacement of Artillery destined to act offensively or defensively. In the modern use of the word it likewise means the equipment of a certain number of pieces of Ordnance, which has been previously explained in the article 'Artillery.'

A Battery may be with or without embrasures; in the latter (en barbette) the height of the genouillère* varies according to the description of gun carriage used.

	ft.	in.
For Field or Travelling Carriages it should be .	3	0
Garrison Carriages	2	3
Ship do.	1	6

or for Guns on Traversing Platforms, to fire over a parapet, 6 or 7 feet high.

Batteries, when with embrasures, have these openings cut or built in the parapet not less than 18 feet from centre to centre, except in breaching batteries; the mass between the embrasures forming a trapezium is called the Merlon. The thickness of the parapet towards the enemy depends upon the nature of the Battery, as is explained in Section VIII., and article on the 'Penetration of Shot.'

The Artillery (which constitutes the Battery—the parapets being merely the cover or protection from shot) requires substantial bearings either of solid ground for field pieces, or of timber, plank, or masonry platforms, for heavy Artillery.

Batteries are divided into Siege and Field Batteries, as well as for the defence of coasts and that of places: the two last will be treated of in the article 'Defence.'

In the British Service, the construction of Batteries is an Engineer operation: this arrangement, different from that of most countries, probably arose from the nature of duties peculiar to our mode of warfare, generally confined to maritime expeditions and irregular attacks, where the construction of Batteries and communications, and perhaps a parallel connecting them, constituted the principal works to be executed; and as the disembarkation of the ordnance, the park, laboratory duties, and placing the artillery in battery and working it, was sufficient to occupy that force, when celerity and the effect of a powerful fire was of the first importance. This arrangement it has been found convenient to continue; and the employment of Engineers and Sappers in the construction of Batteries permits an uninterrupted

* See Plate P.169. Vol 2.

series of operations, which the French Engineer Officers are inclined to think the best.—See Major-General Pasley's 'Practical Operations of a Siege,' Article 221. Second edition.

SIEGE BATTERIES.

SECTION I.

DEFINITION.

These Batteries are either for guns, howitzers, or mortars, and have two objects, when employed in reducing a place.

First,—that of destroying the fire of the fort or fortress, as well as of ruining the parapets and military buildings, in order to approach, with as little risk as possible, to the place attacked; and,

Secondly,—when sufficiently near it, to effect a breach.

SECTION II.

BATTERIES FOR THE FIRST OBJECT, OR DESTRUCTION OF DEFENCES.

The early Batteries constructed in the First or Second Parallels, or from 30 to 50 yards from them, but sufficiently near to be protected by those parallels, are designated as Enfilade Batteries, Batteries in Reverse, en 'Echarpe, and Direct Batteries.

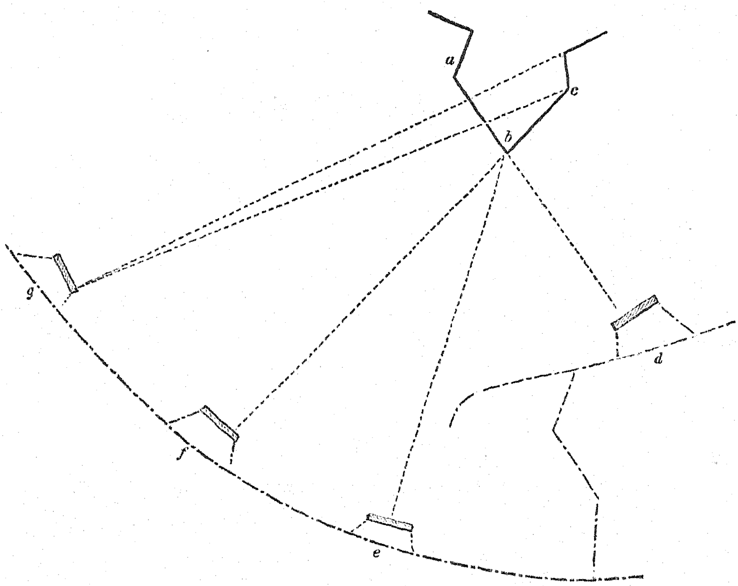
Those for Enfilade and Ricochet are established upon the prolongation of the face of a work, and perpendicular to that prolongation: if that position cannot be taken, from the unfavourable nature of localities, such as rivers, morasses, &c.,—then, by placing the Battery out of the prolongation, taking the interior of the face to be enfiladed obliquely, this will be a Reverse Battery: when the same circumstances occur on the other or exterior side, this will be a Battery en 'Echarpe: lastly, when the Battery is opposite and parallel to the face it should destroy, it is there termed a Direct Battery. The first of these four positions is the best, as its raking fire does much to clear the whole length of the line of its defenders and defences: the second has the same advantage, though to a modified extent.

The third and fourth are the least advisable, because it takes a considerably longer time to effect the object—the ruin of the parapets. Theoretically, the ricochet fire is the most efficacious, although in practice a difficult and nice operation, and only perfectly successful when long faces are open to enfilade.

The diagram subjoined will explain the position of the different Batteries which may be required to ruin the defences of a fortified place: *a*, *b*, *c*, representing the bastion attacked, *f* will be the Enfilade Battery, *g* that of the Reverse Battery, which subjects one face and flank of the bastion to reverse fire, and the adjoining curtain to enfilade fire; but the position of this Battery is a dangerous one, being liable to be overlapped and easily destroyed by Sorties by its contiguity to the place; it can only therefore be taken when a river or marsh intervenes.

The Battery en 'Echarpe may be necessary by the peculiarity of the ground, which prevents the parallel being extended as far as *f*; and the front of attack not reaching even as far as *e*, may render the Battery *d*, for direct fire, only available for the destruction of the defences of the bastion.

Diagram 1.



SECTION III.

BREACHING BATTERIES.

The position of Batteries to effect a practicable breach is contingent on the cover given to the body of the place attacked.

In sieges on paper they are generally placed on the crest of the glacis, but it may be at 50 or 500 yards, just as the walls are exposed; the adoption of the near or distant Battery being a question of time and expediency: ten guns at the shorter distance will probably effect a breach, 100 feet wide, in 17 hours; and the greater in 74 hours;—see article 'Breach.' But it may so occur that the escarp may be seen from a distant Battery, when it cannot from any intermediate point, except at the crest of the glacis; for instance, the guns of the Battery *f*, in the preceding diagram, may be able to breach the face *a*, *b*, of the bastion, by being on rising ground, which slopes to the foot of the glacis: as regards time, therefore, it will be in favour of the distant Breaching Battery; the ulterior operations being confined to Sapping and Mining.

For the principles which generally regulate the *Emplacement* of Batteries, see article 'Attack,' by Major-General Sir J. Burgoyne.

SECTION IV.

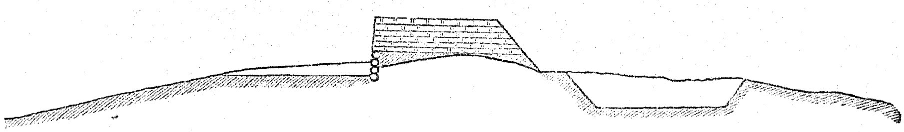
CONSTRUCTION OF BATTERIES FOR RUINING THE DEFENCES.

The construction of these may be as *Cavalier Batteries*, where the terreplein is raised above the level of the natural ground: *Sunken Batteries*, where the sole of the embrasure is on the general level of the ground: and *Half-sunken Batteries*, when the platform is about half the height of the genouillère below the level of the ground. These Batteries are exceptions to the general rule of constructing them,

and cannot be provided for by tables, or suggestions for their execution, without complicated statements of details, depending entirely upon local circumstances and the nature of the soil, which is well explained in Section XII. from Sir J. Burgoyne's Notes. Sometimes it is necessary to elevate a Battery to preserve it from an inundation, or to see an object which the artillery on the natural soil could not touch; and the ground sometimes requires a Sunken Battery to be constructed on the side of the hill sloping towards the place attacked.

The Batteries common at sieges, whether for guns, howitzers, or mortars, are *Elevated* and Half-sunken Batteries; the latter constructed, if possible, on the crest of rising ground, the slope falling from the place as explained in the diagram below: this position is most favourable, as the part to be revetted need not be below the excavation of the platform, and the position is very secure.

Diagram 2, of a Half-sunken Battery of 1 ft. 6 in. depth.



The Elevated Batteries, executed on the level of the natural soil, are simple in their construction; the Half-sunken being a modification of the Elevated, (vide Pl. I. figs. 1, 2,) which it is easy to provide for at the moment, by making the necessary deductions, according to the figure of the ground where the Half-sunken Battery may be placed.

SECTION V.

TRACE OF THE ELEVATED BATTERY FOR GUNS OR HOWITZERS ON THE NATURAL LEVEL OF THE SOIL.

The tracing of this Battery for the destruction of the defences, whether for ricochet or direct fire, is usually executed by the Senior Officer of Engineers of the Brigade to be employed. After the Director of the Trenches has decided in conjunction with him the exact position of the Battery, he should lay out the line of fire during the day; and when dusk, trace out the Battery in the following manner, taking care to be provided with a

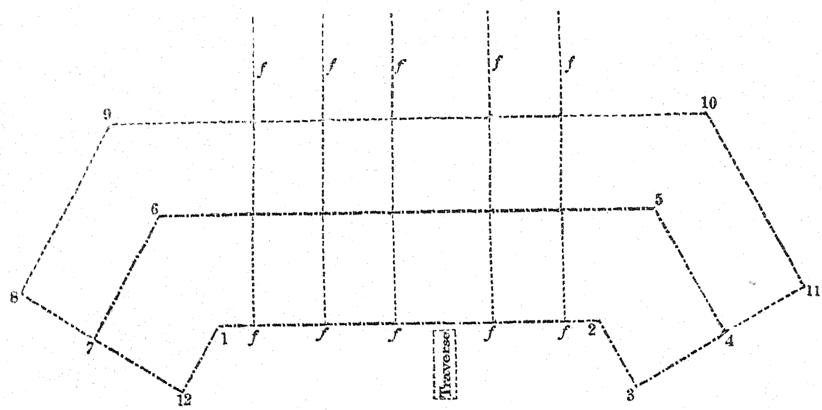
Hambro' line,
A square, or mason's level,
Two dozen pickets, 18 inches long,
Two long pickets, per piece, of 4 or 5 feet, to mark the embrasure,
A mallet,
Crow-bar to penetrate very hard ground,
And a 50-foot tape.

Each and all of these articles are necessary; and without them, difficulties will occur when it is dark.

Thus provided, the Engineer Officer will trace the foot of the parapet perpendicular to the line of fire previously laid, fixing one end of the Hambro' line upon a picket driven firmly in the ground at one extremity of the base of the interior slope of the parapet at the point marked 1, in diagram No. 3, and then stretched to the other extremity marked 2; from thence to the end of epaulement or shoulder, 3; from this, to the berm at 4, 5, 6, and 7, shewing the interior line of the ditch of the Battery to be excavated; from 7 across to 8 (the width of the ditch at the shoulder), and again

to 9, 10, and 11, forming the exterior line to be excavated, to picket No. 4; there make fast, having previously taken one turn around each, keeping the Hambro' line as tight as possible, without drawing the pickets out of the ground: a short line is required to make good the trace of the Battery not yet marked out from 1 to 12, and from 12 to 7.

Diagram 3.—Tracing of a Gun or Howitzer Battery for five pieces of Ordnance.



A reduced thickness may be allowed for the epaulement if it much exceeds such a length as given above.

When the tracing is completed, the line of fire (or centre of each embrasure) must be carefully marked by fixing the cross pickets at *f f* in the diagram, and with sufficient length out of the ground just above the genouillère, so that there should be no mistake when the cheeks of the embrasure are laid out and require to be constructed. When the tracing is completed, a Non-Commissioned Officer should be left in charge to prevent the pickets being disturbed, in the event of any time elapsing between the completion of the tracing and the arrival of the working party. The tracing of the magazine will be done next morning.—See Section XI.

Mortar Batteries constructed on the level of the ground will be done precisely in the same manner, omitting the marking of the embrasures.

SECTION VI.

CONSTRUCTION OF BATTERIES FOR THE DESTRUCTION OF DEFENCES.

Previous to the tracing, the Senior Engineer of the Brigade will make his arrangements at the dépôt for his tools and materials, having them ready according to the Estimate provided in Table II., and the number of pieces of Ordnance of which the Battery is to consist; he will leave his Second Officer then to take down the working party towards dusk to the trenches with such articles as will be required in the first relief;—the second relief taking the remainder (or platforms and magazine framing) next morning: this will prevent much confusion. It will be found con venient to divide the first party into three portions,—the excavators to be employed in the ditch,—those to be employed on the parapet,—and the revetters, and those to be employed on the communications to the rear,—and set the first portion to work as soon as it is sufficiently dark, by leading them from the trenches, between the tracing

lines and pickets,—4, 5, 6, 7, 8, 9, 10, and 11, of preceding diagram forming the ditch to be excavated. To this party should be added a Sapper in the proportion of one to each gun, in order to instruct the men in their work: the whole party of excavators, each having a shovel and pick, will be arranged about 3 feet or the length of the shovel from the line of the berm, and 4 feet apart from each other: when thus placed, they will break ground with the pickaxe, and when a sufficient quantity is loosened, the shovel will be used and the earth thrown over the berm line for the parapet.

As soon as the first portion or excavators are steadily at work, the second portion may be brought out from the trenches, one half placed on the berm to throw the earth forward, and the other half employed in adjusting it according to the line marked 12, 1, 2, and 3, for the parapets.

In a few minutes more the third portion or revetters and party for the communication may be set to work; and the first row of fascines (gabions, casks, or sand-bags, as may be afforded) will be laid, taking care to prepare a proper footing for the first course. The relative merits of revetting materials is discussed in Section VIII., and the quantity necessary is provided in Table II.; as before intimated, one Sapper *at least* per gun being attached to the revetters.

Assuming therefore that it is a Battery for five pieces of Ordnance with one traverse and two shoulders, as described in diagram No. 3, and according to Table II., it will be seen that of the 132 men employed—

42 are in the ditch as excavators,
42 on the berm, and adjusting the parapet,
42 revetting and assisting, and forming the communication to the rear,
6 men on the traverse.

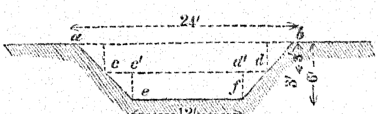
For this work they have 44 picks, 88 shovels, 22 rammers, 7 hand saws, 22 fascine mallets, 168 fascines (if revetted with fascines), 1176 pickets, and 45 gabions.

The first party thus employed ought to excavate to the depth of 3 feet in the eight hours, or 1 cubic yard per hour for each in that time.

Task-work is advocated by Sir J. Burgoyne in the article 'Attack;' that is, to give the men a fair job, and if they finish one or two hours before the relief comes, they should be allowed to return to their camp, without waiting for the completion of this term.

The most simple plan of arranging task-work, and adapted to the comprehension of the men, seems to be, by telling them that so soon as they excavate to the depth of the length of the shovel, between the Hambro' lines, they may go; and explaining to them that the breadth of the bottom part will be only 18 feet instead of 24, as at the top: this they will easily understand.

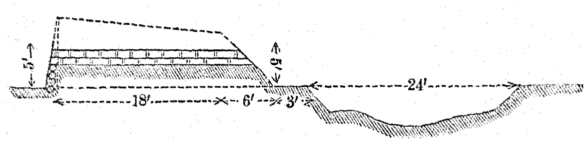
Diagram 4.—Section of Ditch of Battery, representing a double Task,



a, *b*, *c*, *d*, shewing the task of the first party; and *c*, *e*, *f*, *d*, that of the second, which will be about $\frac{5}{7}$ of the first; but they have a greater distance to throw the earth from the ditch.

Distribution of the Relief or Second Party for the Construction of the Battery.—Near the expiration of eight hours (the usual period given for a working party in the trenches), the relief, of the same strength as the first, will be brought down by an Engineeer of the Brigade, who will have been sent to meet them, and conduct them to the spot. By this period, the Battery should be completed to the height of the genouillère, and part of the merlons, to the height of 5 feet, as shewn in diagram No. 5, unless unusual difficulties have been encountered from the nature of the soil, and from the heavy fire of the place.

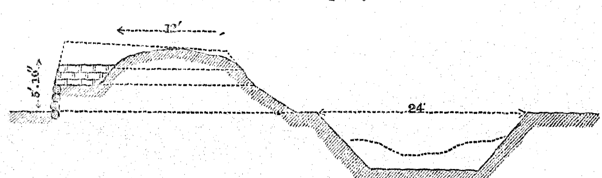
Diagram 5.—Shewing the state of the Battery at the termination of the work of the 1st party.



The arrangement of this relief will be as before, until daylight, when they should be changed, and the men removed from the parapet altogether, to prevent unnecessary casualties, as little is now gained by hastening the work, since the guns cannot open until daylight of the second morning; or in anticipating events in a regular siege, such as bringing in the guns and opening a partial fire, when the stores and ammunition are not collected in sufficient quantities.

It is therefore proposed, in cases where the Artillery will not be required to open fire until the second morning, that the earth thrown on the berm and superior slope should be left there in a heap until next night, which will mask the Battery and allow the interior to be continued without difficulty, as explained in diagram 6.

Diagram 6.—Shewing the state of the Battery at the termination of the work of the 2nd party.



Adverting to the change of the party, and the removal of the 42 men from the parapet and berm, they should at daylight be placed in improving the communications to the rear or parallel as may be, and to the ditch of the Battery; and the revetters may now revet the profile of the shoulders at the same time.

The communication or road from the Battery to the rear or parallel is presumed to have been commenced at the same time as the Battery, and Table No. II. provides for the men and tools for every 5 feet, the length of the tracing fascines: this removal from the parapet of 42 men is only to improve, give the necessary width, and render the arming of the Battery easy and convenient.

The third party, which will arrive about 10 A. M. of the first morning, should bring down any remaining platforms and materials for the magazine; the execution of

which is explained in Section IX., and the number of men and quantity of tools and materials given in Tables IV. to VIII.; taking care, in laying the platforms, that the sleepers have good firm bearings, with a slope of ½ an inch to the foot, and (transversely) laid on a perfectly dead level.

The last Engineer operation for the completion of the Battery will require a relief of about 72 men, to cut through the screen, which masked the work, for the embrasures, revetting them, and filling in the merlons: this should be commenced at dark of the second evening.

SECTION VII.

BREACHING AND COUNTER BATTERIES.

The construction of a Breaching Battery may either be effected as already explained in Section IV., and similar to all other Batteries executed at a distance from the place attacked when forming one of the early works of the siege;—

Or, by converting a lodgement into a Breaching Battery.

The first description being already disposed of,—

The conversion of the lodgement only has now to be explained. This operation is of two different kinds, and methods of proceeding. *One* may be performed on the reduction of an outwork, from whence the escarp of the place can be breached,—the lodgement converted into a Battery,—and the earth taken from the inside, instead of the ditch, as is usual in other Batteries.

The *second*, the conversion of the crowning of the glacis into a Breaching or a Counter Battery by Sap.

First—The execution of a Breaching Battery, when a lodgement is secured in an outwork, is not difficult, although dangerous, inasmuch as the fire of the place can hardly be expected to be entirely overcome. The first operation will be, giving a full thickness of 18 feet to the parapet, and revetting the interior slope; this last, for expedition, may have the lower part made of gabions or casks, which will serve to the height of the genouillère, and leave the merlons to be revetted after dark, when the embrasures are cut. The next work will be the widening the space for the platforms, and making the communication to the rear, as the earth must be obtained from a considerable breadth, little depth having been previously given. Sand-bags and ballast baskets will come into requisition for clearing, filling the gabions, and giving sufficient bulk for the parapet of the Battery.

This description of Breaching Battery will probably be commenced the morning after the lodgement is effected in the work (having reference more possibly to when the guns are required to open their fire), and as this will be done by daylight, the minimum number of men should be employed.—Vide Table III.

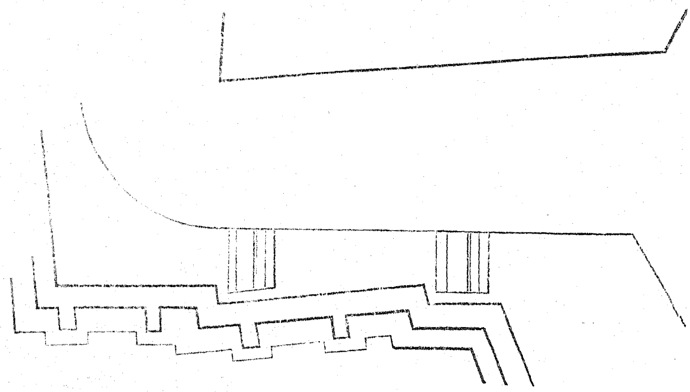
At mid-day the Battery ought to be ready for laying the platforms, and for the construction of the magazine; it would be so if *given as a task* to the men.

The party for laying the platforms and magazine will be regulated by Tables IV. to VIII., and the work executed according to Sections VIII. IX., and before dark should be ready for the artillery.

The last operation—of opening the embrasures and revetting the merlons—may be performed at some convenient opportunity during the night, when the Battery is clear from other workmen, and the artillery of the place has perhaps slackened its fire. When the openings of the embrasures are cut, a sap roller should be rolled into the extreme opening. A few of the most skilful revetters should be employed, and fascines used in preference, as they stand longer than gabions and would last, if well done, until the place is reduced. The merlons could be revetted with fascines, and filled in properly in 3 or 4 hours, if not under a very heavy fire.

The Second description of Breaching Battery to be formed, is that from the lodgement on the crest of the glacis; or it may be, for a Counter Battery, the difference being only in the solidity of the parapets. This requires a longer and a nicer operation, and should be executed by Sap, or rather enlarging the existing Sap, so as to give space and breadth for the Battery.

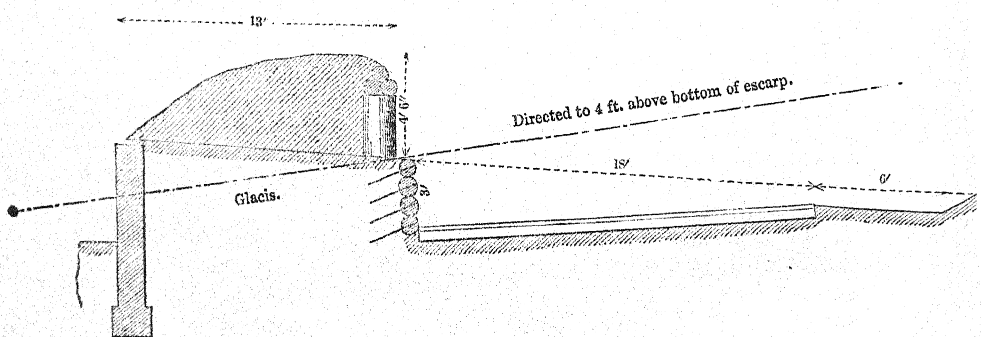
Diagram 7.—Shewing the Lodgement on the Crest of the Glacis.



As the Sapping advances—for the construction of the Battery may be considered to be by Sap, not in the ordinary way—they proceed to re-form the parapets as well as the traverses of the lodgement to the proper height, and give the latter sufficient length (24 feet) to cover the whole Battery. When these are completed, the space for the magazines will be cut out, and the framing fixed and covered according to Section xi. and Table IV. This work, and the laying of the platforms, may be executed before night, so that the artillery may be brought in, and the ammunition stowed away before next morning.

The last Engineer operation to the Breaching or Counter Battery will be the opening of the embrasures and revetting them. At this period of the siege the fire of the place may be considered to be kept under, if not subdued; and to render this work as secure as possible, it is proposed to construct the embrasures in the same method and manner as before, by Sap.

Diagram 8.—Section of the Breaching Battery preparatory to the opening of the Embrasures.



The materials* necessary for embrasures being collected (according to Table III.) in the adjoining trenches—at some convenient period after dark, the Sappers will commence the interior opening by clearing in front and cutting away as much of the parapet as will give space to plant a gabion on each side for the lining of the cheeks of the embrasure, as shewn in the following diagrams:

Diagram 9.—1st process.

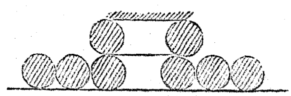


Diagram 10.—2nd process.

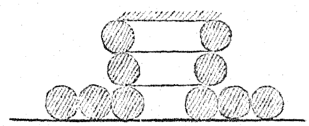


Diagram 11.—3rd process.

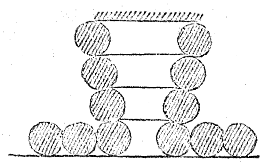
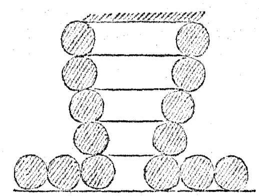


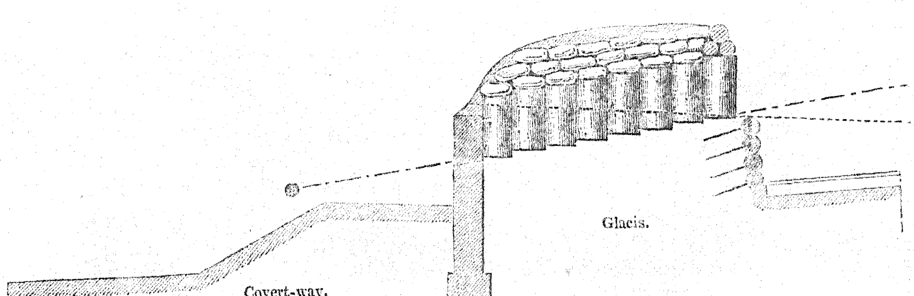
Diagram 12.—4th process.



And the earth taken in front will serve to fill the gabion just fixed, remembering that every gabion will be a few inches lower, in order to give the necessary slope to the sole of the embrasure; so that the work will advance step by step, each gabion fixed and filled from the earth in front, until within 2 feet of the crest of the covert-way. When the gabions are all planted, the completion of the lining of the embrasure upon the gabions will be with sand-bags, laid firmly, and with a slope: this method is selected to suit the irregularity of the position of the gabions, and likewise to expedite the work, the sand-bags having been previously filled and brought to the spot; and as they will not be immediately exposed to the explosion of the gun, they will in this case serve the purpose. Two rows of fascines will complete the interior height of the parapet, fixed on the gabions.

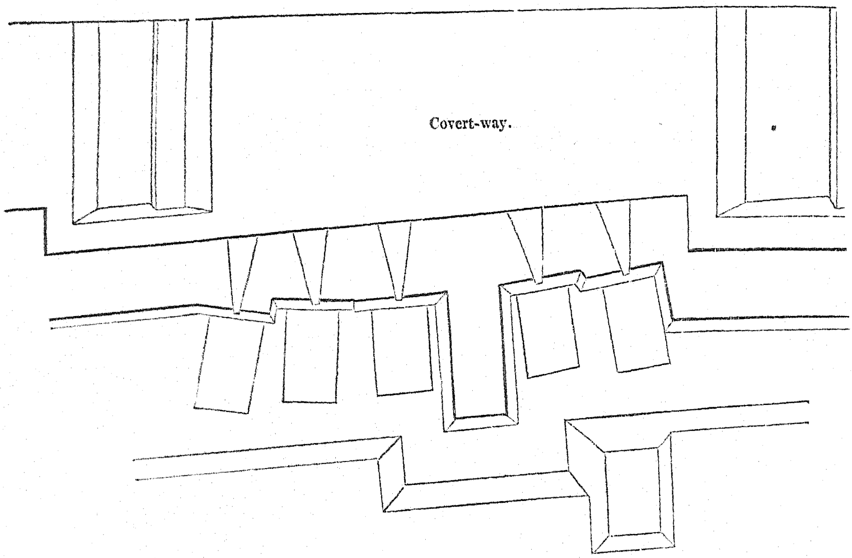
The following diagram explains the embrasure when completed:—

Diagram 13.—Section of the Embrasure of a Breaching, or of a Counter Battery.



* In this particular operation, gabions are preferred.

Diagram 14.—Breaching Battery in the Crowning of the Covert-way.



It is conceived that this novel mode of constructing Breaching Batteries on the crest of the glacis will be found to be as successful as practicable: in any other mode of forming the embrasure, the opening of each must be cleared 4 feet at the interior opening, and 11 at the exterior; several men must be employed to execute that work and revet it afterwards; whilst in the method here proposed, only two are necessary, and they only partially exposed.

Before daylight, a Miner to each embrasure will be required to clear the remaining part unopened, and cut away a portion of the brick-work or masonry of the retaining wall of the crest of the covert-way, which, with a crow-bar, may be done in a few minutes.

When the work is completed, and the artillery run in, the embrasures should be furnished with mantlets, hung on the interior opening, to protect the Artillerymen from musketry fire; they may be made of three 3-inch deals, or two 2-inch oak planks, spiked together as shewn in Plate II. fig. 6.

CONCLUDING REMARKS.

The Author of the foregoing pages offers the following remarks upon Siege Batteries, arising out of some differences of opinions on minor points in the Construction and Position, &c.

First, he is inclined to believe that all working parties, after the completion of the first parallel, should have their arms; for this reason—if a Sortie, or the alarm of a Sortie, occurs, the workmen have no rallying point, and they, or the most of them, return to their camp; whilst if their arms are piled, or laid securely, not far in the rear, they will invariably stand to them, and ~~receive~~ orders how to act.

Secondly, respecting revetting materials, it appears that the relative advantages of fascines, gabions, casks, or sand-bags, consist more in their application than in the peculiar merit of one or the other; and each may be employed usefully in revetting Batteries.

Lastly, the subject of Siege Batteries resolves itself into but two descriptions as regards the construction or labour: those in which the parapets are taken from the ditch; and those formed from earth taken from the interior or terreplein of the Battery. Any deviations are only modifications of these two.

There is one description of Battery not adverted to, but which is one of the second class, *i.e.* the Siege Battery en crémaillère; this is constructed under peculiar circumstances by the conversion of an embankment of a canal, or dyke, on the bank of the opposite of a river, into a Siege Battery, and the materials taken from the inside.

G. G. L.

SECTION VIII.

REVETTING SIEGE BATTERIES, FROM NOTES* BY MAJOR-GENERAL SIR J. F. BURGOYNE, R.E.

Batteries may be revetted with sand-bags, gabions, or fascines.

SAND-BAGS.

The sand-bag is a very favourite material for Batteries in our Service, but it does not last: such Batteries not only require constant repairs all day, but the embrasures† must be rebuilt every night, to the great expenditure of sand-bags, and labour of Engineers and men. When, from want of time, or other causes, ground is to be broken immediately on the investment, and the Batteries are to be commenced on the first or second night with a small besieging force, it is probable that Sand-bag Batteries *must* be employed with all their disadvantages: also, in distant batteries against small works, they may not perhaps cause much harm; but all this does not prevent their being the most inferior material for revetting. They do better for mortar batteries or traverses, and very well for magazines. In revetting with sand-bags, they should be laid headers and stretchers, with a slope of one-sixth at least.

GABIONS.

Neither are gabions good for revetting a battery, (beyond one row on the ground to the height of the genouillère, perhaps,) on account of the number of joints, except in the conversion of a lodgement into a Breaching Battery (see Section VII.), the time and trouble required to lay them to a proper slope, and the great difficulty of repairing them, especially in the embrasures, when out of order. They make very good traverses, and are required for masking embrasures. The dimensions for sap gabions need not be adhered to in those required for batteries.

FASCINES.

The best revetment is doubtless made of 18-feet fascines, 10 inches in diameter; each of these, being long and pliant, will bend to the settling of the earth; they are quickly and easily applied, present no joints to be loosened by explosion of ordnance, and, unless the fascines are very bad and loosely made, will not catch fire.‡ Those

* For this, and Section XII., written at Ciudad Rodrigo shortly after the siege of Burgos.

† After a few rounds, these embrasures become so damaged and open, as to expose the Gunners considerably, and frequently become choked by the stuff that falls down. It takes upwards of 800 sand-bags per gun at first starting only.

‡ A fascine battery (of long fascines) at Messina, made by the Neapolitan Artillery, for Instruction, and which had stood for five years, and had constant practice from it with heavy guns, was in perfect order. At the siege of Almeida, in 1810, the cheeks of the embrasures, of stone, sod, or tapia, were all injured by the explosion of their own heavy guns; some, however, that had been opened on the moment, and lined with fascines which had been in store a year, (and therefore not so good as when green,) stood perfectly, and did not burn.

6 or 8 feet in length have not the same advantage, being short, and consequently stiff, are more likely to be forced out by the swelling of the earth, and their only superiority lies in their portability, the materials, men and time, being identical in both.

With reference to fig. 1, Plate II., the number of 18-feet fascines for a 2-gun Battery will be

For interior lining	23
For cheeks of embrasures	20
Memorandum.—9 out of the 23 will be cut into short lengths, to break joint, &c.	
To which must be added, whatever may be the number of guns,	
For the two epaulements (if 18 ft. long)	18
Also, when traverses are used,	
For additional length, given by their breadth, to the parapet, per traverse	4
	65 *

The lower row is sunk about half its diameter in the ground, a trench being cut to receive it.

The first fascine is laid next to one end of the Battery, and is picketed down, beginning from that end, all but the last picket: this end is left loose, to enable a Sapper sitting across it to hold it up, while three or four of the party, (according to its length,) standing across the second fascine, which they hold in both hands, all fronting the first, after two or three swings, drive it well into the first; if not quite even, it must be taken out, and the process repeated, as any error in the first course will be felt throughout.

The other fascines are fixed in like manner.

The interior slope of the parapet is 2 feet, or about a quarter the height.

The pickets to be driven as shewn in fig. 5, Plate I., each *a, a,* passing through two fascines; and they are driven till their heads are buried in the upper one. An 18-feet fascine should have seven pickets, the knots of the gads (or withes) to be turned inside; and care must be taken not to drive the pickets into these last, as they are likely to be cut thereby. Pickets may be occasionally driven as *b, b,* independently of those as above marked *a, a.*

When Batteries are near the place, much cover from musketry for the Gunners is given by the fascines lining the embrasures being spread like a fan, *i. e.* vertical at the neck, and sloping at the regular slope of one-fourth at the other extremity. The interior ends are to be brought quite flush with the interior (fig. 1, Plate II.) slope of the parapet, as joints near the point of explosion are avoided; and less damage is done if a shot strikes these fascines, than when it disturbs those belonging to the interior of the Battery, which by this plan are covered.

The slope given to the sole of the embrasure must depend on the relative level of the object fired at; if for enfilading, it may probably *rise* from the interior to the exterior.

The interior opening at the bottom of a gun embrasure is 22 inches wide; the exterior opening will be regulated by circumstances, but usually, half the thickness of the parapet as a direct embrasure.

In revetting Howitzer Batteries, the neck must necessarily be wide, if mounted on a travelling carriage,—at least, 2 feet 6 inches,—from the shortness of the piece not

* This, with full allowance for waste, has been observed in Table II., 'Battery.'

allowing it to enter the embrasure when on its travelling carriage. In this case all that can be done is, to give the Gunners what cover can be allowed consistently with the scope of the howitzer, and by the use of the mantlets, if brought within musketry fire after the guns of the place have been silenced.

The same remark applies to carronades; they were used occasionally in the Peninsula.

REVETMENT OF MORTAR BATTERIES.

These, having no embrasures, require more stuff in the parapet. The superior slope is reversed. They are revetted like other Batteries when the materials are abundant; if not plentiful, and the Batteries are not seen into from the place, then perhaps a half-revetting, as with a row of gabions: if the soil is stiff, it may be dispensed with; but if practicable, revetting is in every way more satisfactory.

The centres of the platforms to fire

at 45°	should be	12 feet	from the parapet, when near the place.
„ 22°		31 feet	
„ 15°		48 feet	

Thickness of parapets against	Heavy guns . . .	18 feet thick.
	12 or 9-pounders	. 12 or 14 feet.
	6-pounders, &c.	. 8 feet.
	Musketry . . .	. 4 feet.

SECTION IX.

PLATFORMS.—COMMON OBLONG PATTERN.

To lay a Platform well, as used in the last war, the sleepers should lie in trenches, or, at least, as much of their front ends as is required to give them a slope of ½ inch to a foot; the intervals between must be completely and solidly filled in with stones, and brought up flush with earth. If earth alone be used, it must be very well rammed.

When three sleepers only can be allowed, as is sometimes done in Breaching Batteries, there must be one under each wheel, and one in the centre. The hurter is laid on and fixed to the sleepers. The planking is commonly all spiked down to the sleepers; but that mode is noisy, troublesome, and renders the removal and use of the materials again difficult.

It is best, especially when there are five sleepers, to confine the planking by ribands laid on it, and screwed* through it, at three or four points on each side, into the outside sleepers below. If the screws are well greased before insertion they will bear several removals: they should go through the sleepers, and may be fitted with nuts, which last must be uppermost.—Vide Plate III. figs. 3, 4.

Platforms with three sleepers laid parallel, and the planks only 12 feet long, are quite sufficient when the guns are not to traverse, which commonly is not requisite during a siege.

Where expedition is not necessary, it is important to have the sleepers well squared, and the planking of uniform thickness.

Mortar Platforms, usually 8 feet square, are laid as above; but in sandy soils, the difficulty of giving stability to the platforms is entirely obviated by the use of a fascine, or junk foundation, in two crossed courses at right angles to each other.

The common oblong Siege Platform for guns on travelling carriages, $18' \times 12'$, on

* As recommended also by Sir John Jones, in his 'Sieges,' and used in the last war; but since then Lieut.-Colonel Alderson, R.E., has proposed a platform which has been found to answer thus far, and of which the subjoined account, p. 142, is written by that Officer.

five sleepers, even when laid with screws and ribands, instead of the planks being spiked down, weighs upwards of 26 cwt.—Plate III. figs. 3, 4.

J. F. B.

MADRAS PLATFORM.

The Madras Platform, used in the Indian Army, (Plate III. figs. 1, 2,) promises all the efficiency of the above, without its disadvantages, weighing only 7 cwt. Attempts have been made to apply the same principle to Mortar Platforms, but hitherto unsuccessfully, as no reduction in weight has been effected in consequence of the great strength necessary for the different pieces. The common mortar platform, $8' \times 8'$, on four sleepers, with the same scantling as that for gun platforms, requires stuff far more readily obtainable, and more convenient for transport. Both this last, and the Madras mortar platform, weigh about $8\frac{1}{2}$ cwt.

In constructing the Madras platform care must be taken that the side pieces and transoms make one compact framing, the whole traversing on one front pivot, instead of on two or three, which has been proposed, and which limits the extent of traversing, from the side pieces approaching each other, like those of a parallel ruler, when moved.

All fastenings should be made with screws (instead of nails), which, if well greased when first driven, will admit of the whole being taken to pieces repeatedly. The trail piece, A, is steadied by cleats, and merely drops into its place; it will not be required when garrison carriages are used.

SIEGE GUN AND MORTAR PLATFORMS, INVENTED BY LIEUTENANT-COLONEL ALDERSON, R.E.

1. The object of the construction of the Siege Gun and Mortar Platforms is to place the Artillery in Battery on hard level surfaces, capable of retaining their position and of enabling the Artillerymen to make correct practice with fewer men, from the facility afforded for running the gun or mortar up after each discharge.

2. As these works have generally to be laid under fire, and frequently during the night, the more simple their construction and the more uniform their parts the better, &c.

3. The Gun Platform now to be described, and which has been satisfactorily proved by the Royal Artillery practice at Woolwich, has therefore been made to consist of baulks of uniform length and scantling, which serve for both sleepers and deck.

Each baulk is a piece of fir timber 9 feet long, $3\frac{1}{2}$ inches thick, and 5 inches wide, and weighs about 37 lbs., sufficiently light to be carried to the spot by one man, besides his arms and ammunition; and, being universal, it will fit into every part of the platform.

4. This is the *minimum* size; but, if made on the spot or in the field, the principle may be equally adapted to any other increased dimensions; and thus render available such timber as may be found at the time with the greatest economy of materials and labour.

If constructed of the minimum dimensions above stated, a gun platform, 15 feet by 9, will consist of

	cwt.	qrs.	lbs.
46 baulks, with 47 trenails, (10 inches long and $\frac{3}{4}$ inch diameter, each of which makes 4 dowels, $2\frac{1}{2}$ inches long,) 1 oak trenail being added for the rear centre pin of platform . .	15	0	22
9 round iron pins, 11 inches long, including the eye	0	0	18
10 iron shoes, and 20 inch screws	0	1	2
Total weight	15	2	14

Figs. 1 and 2, Plate IV., represent a baulk of the above-named dimensions, with eight holes bored $1\frac{1}{4}$ inch deep and $\frac{3}{4}$ inch diameter, at the distances specified, four on each of two opposite sides, both sides being alike when taken from opposite ends.

Oak dowels, $2\frac{1}{2}$ inches long and $\frac{3}{4}$ inch diameter, (four of which are obtained from each trenail,) are then introduced half their length into the holes; on one side of each baulk (figs. 1 and 2,) *a*, *b*, *c*, *d*, represent the dowels, and *e*, *f*, *g*, *h*, the holes.

5. Into the end of the dowel which enters the baulk, a fox wedge (fig. 3,) is introduced to prevent the dowel dropping out. The dowel is then $1\frac{1}{4}$ inch within the baulk, and projecting the same beyond it; this projection fits into the holes of the next baulk.

6. In order to lay a gun platform, take any ten of the baulks, and dowel them together two and two, as shewn at C, D, fig. 4; each two baulks will then form one sleeper, 15 feet in length.

7. It is to obtain this length that the holes are bored at the distances specified. Two iron shoes, 2 inches broad and $\frac{1}{2}$ inch thick, are then fitted in, and fixed with a small screw, as shewn in figs. 4 and 5, to keep the sleepers steady.

8. Fig. 6 shews how the sleepers may be made 18 feet in length from the same baulk, should it be requisite, from the nature of the ground, to prevent the trail of the gun recoiling off the platform, which a 32-pounder invariably does with Service charge, when the platform is 15 feet in length, laid with the usual fall to front of $\frac{1}{2}$ an inch per foot.

Each platform requires five sleeepers, which must be laid in the space of 9 feet, the width of the intended platform, as shewn in fig. 4.

9. The platform is now laid in the usual manner, by excavating trenches to receive the sleepers, and, after levelling them with the field level, securing them in their places, by filling in the trench on both sides of the sleeper, and ramming it well, taking great care not to injure the sleeper.

10. Prior to commencing the laying the platform, holes $\frac{3}{4}$ inch in diameter must be bored $2\frac{1}{2}$ inches, from one end of each sleeper, and that end is to be placed at the *front* of the platform.

11. Next take any one of the baulks, and lay it transversely on the ends of the five sleepers, over the holes thus bored, and bore five similar holes through the baulk immediately over them, as shewn in fig. 7.

12. Place five iron pins through these holes of the transverse baulk, and through the corresponding holes in the ends of the sleepers; the position of the sleepers in front will then be secured.

13. In the rear, a baulk must only be placed over the ends of the sleepers as a guide, but without boring either, since the *exact* place for the holes cannot be determined until the last baulk of the platform is laid, because it is not *necessary* that all the baulks should be of one width.

14. When the last baulk of the platform is laid, bore through it and the ends of the sleepers, as in front; insert the pins, and the platform is complete.

15. The centre *rear* pin is to be an oak trenail; it will then be flush with the platform, and let the trail of the gun recoil without meeting with any impediment.

16. The platform thus laid is a clear uninterrupted surface of $15' \times 9'$, with the exception of the heads of the pins front and rear, a portion of which is shewn complete in fig. 4.

17. In the construction of this kind of platform, the holes in each baulk must be bored at precisely corresponding distances and heights; and this will be easily done by a dowel box, fig. 8.

k, k, k, represent the bottom piece, for which the carpenter's bench, if long enough, may answer.

l, the end piece placed transversely.

m, m, the front piece through which the holes 1, 2, 3, 4, at the proper distances and height, are to be bored.

n, n, the rear piece or cleat.

o, o, o, o, four wedges to keep the baulk, P, close to the front piece.

One side of the baulk is then bored through the holes 1, 2, 3, 4, with a centre bit; the baulk is then cut off the proper length by the guage shewn by the saw kerf at *q.* The baulk is then taken out, turned over, and end for end being replaced and wedged up, the opposite side is bored as before.

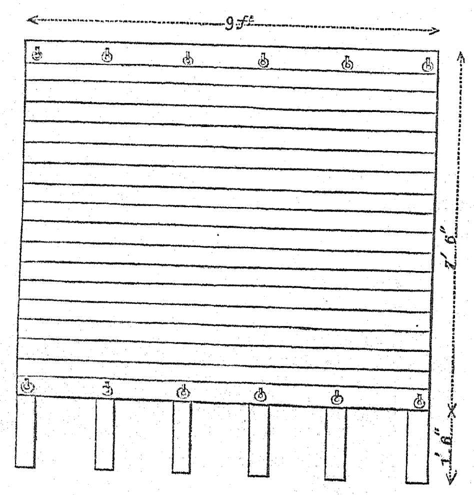
In this way every baulk will be similar in every respect.

18. Iron pins and shoes have been introduced in the construction of these platforms, to enable them to be easier *relaid* during the siege; but for all the purposes of strength the wooden pins or trenails will answer; and the shoes, excepting in bad ground, may be dispensed with, or made of wood, if required.

19. In taking to pieces a platform thus laid, the wooden pins or trenails must be driven or bored out, and fresh provided if the platform is required to be relaid.

MORTAR PLATFORMS.

Platform for 8-inch and 10-inch Mortars.



Siege Platforms for 8 and 10-inch mortars may also be constructed of baulks and pins of the same dimensions as those which have been described in the construction of Gun Platforms.

A mortar platform of this kind will consist of

	cwt.	qrs.	lbs.
24 baulks { 18 as deck, 6 as sleepers }	7	3	20
12 iron pins	0	0	24
Total . .	8	0	16

This will form a platform 9′ × 7′ 6″; the decking can be diminished, or increased to 9 feet square, as may be deemed necessary.

The ends of the sleepers will necessarily project in a platform of the above dimensions; should they be in the way, they can be cut off where the deck ceases; this will, however, prevent these sleepers from being used in any other description of platforms.

This platform has, like the gun platform, been satisfactorily proved by the Royal Artillery at Woolwich.

SECTION X.

TRAVERSES.

All Batteries of more than three pieces should have splinter-proof Traverses, to protect the Gunners from the effects of shells. One between every two guns is generally sufficient. They are made about 6 feet thick at base, and about 6 or 7 feet high. Vide fig. 5, Plate II.

A passage 2 feet wide is left, to enable the Gunners to get out of the way when a shell falls in the Battery, between the traverse and parapet. Its length should extend to the tail of the platforms.

If the Battery is subject to be enfiladed, even by ricochet, as is very common on the crest of the glacis, the traverses must be at least 10 or 12 feet thick; and such being generally Sunken Batteries, as Breaching and Counter Batteries, the lower part of the traverse is left of the solid ground.

J. F. B.

SECTION XI.

MAGAZINES.

The Magazine recommended is that given in figs. 2, 3, 4, Plate II., as proposed by Major-General Pasley.

The lean-to principle is preferable to that in which the walls are carried up perpendicularly.

The baulks should be immediately covered with a tarpaulin, and every precaution taken as to drainage.

A magazine of these dimensions will stow at least 64 barrels; or enough for three 24-pounder guns for one day, at 240 rounds per day. There should be a separate magazine for every three or four guns, though in the same Battery: 6 feet in length of magazine per gun is an ample allowance, at the above rate of consumption.

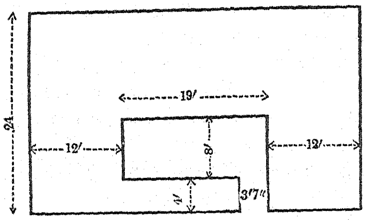
The entrance of the magazine should not be less than 20 or 25 yards in rear of the platforms. In 'Blindage,' Plate III. fig. 4, a section is given perfectly applicable to magazines.

J. F. B.

TRACING AND EXECUTION OF A TRIANGULAR FIELD MAGAZINE,

Abridged from Major-General Pasley's 'Practical Operations of a Siege,' 2nd edition. Vide Plate II.

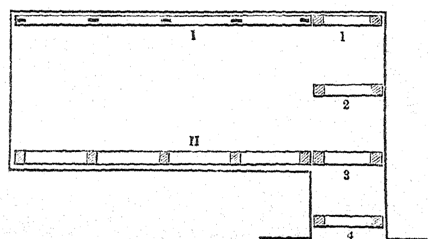
"This is represented in the annexed diagram, in which the body of the magazine, measuring 19 feet by 8, is supposed to have been laid out parallel to the face of the Battery.



"In preparing to place the frame-work of the body of the magazine, the two sleepers for receiving the stanchions and struts were laid parallel to each other, at the clear distance of 6 feet 6 inches apart, in grooves properly prepared, the former being laid horizontally, and the latter at an angle of 45 degrees. These occupied about 15 feet of the length of the excavation of the body of the magazine, the rest of which belonged to the passage.

"When the two sleepers were laid, and the stanchions and struts were connected with each other, and fitted to their respective sleepers by pairs as soon as possible, and the stanchions were secured by wedges or otherwise, to keep them steady for the present,—the four passage frames were then placed, one in the direction of the stanchion sleeper produced; the other parallel to it, at the distance of about 11 feet to the rear, that is, a little in front of the alignment marked for the front of the rear trench: the other two were then set up at equidistant intervals between these two.

"This arrangement is represented in the annexed figure, in which the Roman numerals I. and II. represent the two sleepers, shewing the mortises or notches for the stanchions and struts of the frame-work of the body of the magazine, whilst the numeral figures 1, 2, 3, and 4, shew the positions of the passage frames.



"The sheeting planks were then introduced between the stanchions of the body of the magazine, and the side of the vertical excavation adjacent, until the whole of the sunken part of the magazine was lined with wood-work on that side: after which the upper was revetted by about three courses of fascines; the sheeting and fascines together being so arranged, as just to cover a space of about 6½ feet in height from the sole of the excavation upwards. The splinter-proof timbers were then laid, in the intervals between the triangular frames of the body of the magazine, with the foot of each resting on the strut sleeper, and the top of each lying against the uppermost course of fascines. At the same time, the extreme end and the two sides of the passage were lined with sheeting planks, excepting of course that part of one side which was left open to communicate with the body of the magazine. The whole passage, including the extreme end of the body, was there covered by splinter-proof timbers laid horizontally over all the caps, which being done, the timbers were to be covered by tarpaulins. Plate I.

"In placing the sheeting, fascines, and timbers, the whole of the men were required to hand those materials, which had previously been laid near the spot. As soon as the above were disposed of, the labourers' work again proceeded until the magazine was finished. About three, and not exceeding four, men were employed as rammers; the remainder as diggers and shovellers. In consequence of its being impossible to dispose of all the first excavated portions of earth properly, until the magazine was covered in, as many men as possible were employed as shovellers, by whom the loose earth, especially that in rear of the magazine, was thrown upon the parapet, until it attained the dimensions specified."

For dimensions of the magazine see Plate II., figs. 2, 3, 4.

SECTION XII.

REMARKS ON SIEGE BATTERIES, FROM NOTES OF MAJOR-GENERAL SIR J. F. BURGOYNE, R.E.

The most difficult operation of a Siege is the execution of Siege Batteries, and requires the best Officers to be employed.

It is here that regularity and system are most particularly necessary to arrange the men and stores in such manner that there may be no delay and confusion.

The quickest mode of making a Battery (though but of rare occurrence) is by raising the parapet entirely of materials brought from a short distance in baskets; or with wool-packs and sacks of earth, &c., thrown in. In this way, the revetting, and laying platforms, can be commenced at once; but the mode is only applicable to a small quantity of work, such as a single Battery for a few guns; and even then, the working party must be very strong, the arrangements good, the baskets numerous, and the supply of earth near at hand and abundant.

The next quickest is the Half-sunken Battery, in which the earth is got partly out of the interior (excavated to about 18 inches deep), and partly from the ditch. This may be expeditiously done, and the stuff for the parapet sooner obtained. The most usual mode, however, is to raise the Battery entirely above ground by excavating from the ditch.

The longest and most inconvenient method is that of the Full-sunken Battery, where the interior is sunk to the depth of the genouillère, unless the ground, by falling immediately from the back of the parapet, prevents the excavation being so very great before the platforms can be laid, as it must be in level ground. In executing this sort of Battery, care must be taken that the natural ground does not interfere with the fire of the guns, and a very slight swell will do this.*

fig. 4. If the Battery is on the side of a hill sloping towards the place, the work in the interior will become excessive; as happened at the siege of Ciudad Rodrigo, where, at the tail of the platform, the depth to be excavated was 6 or 7 feet.

ELEVATED BATTERY: BUILT ON THE NATURAL SURFACE OF THE GROUND.

The best, the ordinary, and safest mode—that of excavating the whole from the ditch—may be done thus :—

The foot of the interior slope of the parapet (which is the regulating line in all instances) is first accurately laid out; then a parallel line, at the distance of 29 feet, gives the interior edge of the ditch, Plate I. fig. 1.

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* Major-General Pasley very judiciously recommends, in determining the position of a Gun Battery for direct firing, that in tracing a Battery, the person should kneel or lie down, looking towards the fortress, in order to guard against the inequalities of ground, and to be certain that the guns can hit the object.

The workmen to be placed along the ditch on the line *a*, 4 feet apart, or 5 men per gun.

The depth of the ditch to be 6 feet, to obtain the earth for the parapet, and the task, (if that system be adopted, and particularly if they have a double set,) which may well be 4 feet wide, and 6 feet deep, should be complete in 24 hours. But as that would bring it to a finish at night (Batteries being nearly always commenced at dusk), the additional hours to next morning will afford ample time.

A party of 3 men per gun to be on the berm to throw forward the earth for the parapet, and give a good backing to the interior revetment; they must keep the berm *perfectly clear* all night: this is a point of great consequence, and most particularly to be attended to, because these men, being more exposed, are more liable to shrink from their work. At morning, the whole of the earth should be close to the interior revetment, and not a particle of it on the berm, which can only be done by keeping the men at this work from the first, and not putting it off till the morning: they should also have a relief, or double set; or, in other words, the working party should all take their turn in this dangerous duty.

Three men per gun will also be necessary for ramming the earth well, particularly near the interior of the parapet: this also is a point of great consequence, and very apt to be much neglected; the earth settles exceedingly from the concussion of the firing; so much so, that the merlon will sometimes be seen almost entirely settled down, and leaving the revetting of long fascines standing nearly by itself. In Sand-bag Batteries (where those flimsy materials—sand-bags—are soon demolished), the embrasures choak, and the merlons settle so that the crest of the parapet is soon reduced to a waving line, at most not more than 5 feet above the ground.

At one end of the Battery, a narrow ramp must be made to communicate with the ditch, and enable the reliefs to pass under cover.

The attention of the Officers will be much required,

1st. To the men in the ditch, that they work hard, and do not cut away from the escarp, which they are apt to do.

2nd. To the men on the berm, and rammers, that they remain steady at their post and work.

With these, and the bringing up the various stores *in time*,—revetting the Battery, —laying platforms,—and making magazines, Battery duty becomes a most arduous undertaking, and one that requires nice management to be completed with expedition.

The French mode of excavating the ditch in the shortest time, is by a second row of workmen, 6 feet from the first, not covering but chequered with them: thus, instead of placing one row of men 3 feet apart, which would be crowded, each alternate man is moved out in another line 6 feet from the first; then, the whole working in one direction from the Battery, there will be room for the second row to throw the stuff through the intervals of the first. But independently of the difficulty (which they acknowledge) of carrying this into execution in the night, and perhaps under fire, the excavations will be inconvenient to work in on the following day. Hence a single row, 4 feet apart, is preferable.

HALF-SUNKEN BATTERY.

Plate I. fig. 2. In the execution of these, a row of men, 4 feet apart, will be wanted for the excavation of the interior of the Battery, which may be about 18 inches deep. These men will be occasionally interrupted as the revetting goes on, but not seriously so. The first row of fascines may be laid before the excavation is commenced, it being understood that the fascines of the excavated part are to supersede the hurter of the platform.

The guns must be all ready, with a good access made to the Battery, that they may

be run in during the last hour or two of dark, when they will lie against the merlons till the platforms are laid.

FULL-SUNKEN BATTERY.

Plate I. fig. 3. It would appear, at first sight, in these, that having nothing to raise but the merlons, the work would be much diminished; but the sinking of the whole interior to a depth of 3 feet, with a sufficient passage to the rear, leads to greater labour than that of raising the parapet entirely from the ground, since a Sunken Battery must have a width of about 30 feet, not to be very crowded and inconvenient.* The stuff that will about complete such a Battery will be had at the depth of 2 feet 6 inches or 3 feet, by which we gain that height of solid parapet formed of the natural ground, and a somewhat speedier cover for the men; but the inconveniences are so great, on service, that it cannot be approved of, or considered even the quickest way, for the following reasons:—

1st. The men will cut the 1st trench to the depth of 3 feet to gain cover, 6 inches of which must be afterwards filled in again.

2nd. As the excavation enlarges, the distance to throw the earth becomes great, and indeed requires an additional row of men.

3rd. No platforms can be laid, nor traverses made, nor the revetment carried on, nor even materials brought in, until the excavation of much of the interior space near the parapet is finished: hence not nearly so many men can be employed at the same time as in a Battery entirely raised from the ground, and the materials taken from the ditch, where all things may go on together.

4th. When a parallel is to be converted into such a Battery,—the most common case in which it occurs,—the parapet must be made up solid, and the embrasures cleared out afterwards:† in this, the excavation becomes considerable, which may be easily conceived by adding to the bulk of the embrasure (as finished) that at the cheeks which must be removed to obtain a foundation for the lining; and remembering that the newly thrown up earth is so loose, even when rammed, as to require a great slope to stand whilst the revetting goes on: the consequence is, that in the impatience to open them, which appears at first but a trifling operation, they are almost invariably badly done,—in irregular directions,—and the mouth of the embrasure never so open or so low as it ought to be.

5th. The foundation will be so uneven that the laying of the platforms becomes tedious, and very frequently ill done.

6th. The interior of the Battery is difficult to drain, always confined, and shells are caught by the reverse slope of the excavation.

7th. Magazines, being on the level of the natural ground, are not so well covered by the parapet.

The principal case where this mode may be advantageous, and time gained, is where a parallel has been made, and part of it is to be converted into a Battery, instead of commencing a fresh one in front: in this instance a considerable part of the work is already executed, and may be continued during the day, whilst a new communication is being made round its rear;—it is thus that the Battery may be said to be quickly executed, counting from the time of commencing its conversion to a new purpose.

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* When the fire of the place is still able to plunge into the Battery, even this may not be allowed, as the rear becomes so much exposed.

† An evident loss of time, and an inconvenient practice: it can only be of service when the Battery is to be thrown up some time before it is opened, and the position rendered imperative by circumstances.

These remarks suppose the natural ground to be level and perfectly open in front, without any impediment to the fire: if it falls greatly to the rear, there is a great advantage in sinking the interior. On the crest of the glacis there are many reasons that make it necessary. (Plate I. fig. 6.) If the ground rises to the rear, excavation is unavoidable, but the labour is enormous.—Vide Plate I. fig. 4.

As in Full-sunken Batteries the natural ground forms the sole of the embrasure, it cannot (when level, or rising towards the place) be cut away to admit of guns being depressed, as required in Breaching and Counter Batteries, where the platforms may even have to be raised. When this necessity for depression can be foreseen, care must be taken to leave the bottom of the trench higher than at other points. It is always easy to reduce, not so to replace.

Note.—The preceding details refer to Batteries perpendicular to their line of fire, or nearly so. It seldom happens that they are required with such an obliquity as to render a Crémaillère Battery necessary, except on dykes, and banks of rivers. At Salamanca, one instance occurred during the late war; but there it was cut out of a heap or bank of ruins; thus greatly simplifying the operation, which, when this description of Battery is built and revetted from the ground, becomes extremely troublesome. It has however one advantage, that traverses are not so necessary.

SECTION XIII.

POSITION AND CONSTRUCTION OF FIELD BATTERIES.

The position of Batteries ought always to be on the most commanding and most advanced points, in order to discover the country to the greatest possible distance, and to produce a cross fire on that space which the enemy would have to march over in attacking the position.

If there be in front any road or passage, which the enemy would be obliged to follow, or any grove of trees which there is not time to fell, or any kind of cover whatever which cannot be removed for want of time and means,—we must begin by marking the place for a certain number of pieces to bear on these objects in proportion to the whole number of which the Battery is to be composed, not forgetting those which are necessary to produce a cross fire corresponding with the other Batteries.

However, in the uncertainty ~~that~~ in which we must be with respect to the manner in which the enemy may form his attack, and how he may dispose his line or columns, it is always advisable to ~~mark~~ make some embrasures more than there are guns in the Battery.

It does not always happen that the position commands all parts of the country in front and on the flanks,—on the contrary, frequently, whether on the front or flanks, the position may be on the edge of a valley intersected by a river or rivulet, the passage of which it is necessary to defend; and the opposite banks are of the same height, and not more than 800 or 900 paces distant. In this case, in advancing on the salient points, the first attention is to preserve, at least, equality of height with the opposite bank. But if the slope in front be not regularly formed en glacis, but uneven or forming a double slope, the consequence is, that from our position we cannot discover all the ground in front;—it will be necessary to take down the guns to that part of the slope that sees the whole of the valley. As this will be commanded by the opposite ground, and there is little time to cover the guns sufficiently, we must erect also a Battery in its rear for our heaviest guns to bear on the opposite spot most favourable to the enemy, preserving an equal height, or greater, if possible.

Having established the principal Battery, it is then necessary to take into consideration the principal debouches of which the enemy might make use; namely, the

great roads, bridges which cannot be destroyed, or from some reason preserved, and the places where he is most likely to cross either by fording or pontoons.

When the ground of the position is not en glacis, and from the summit we cannot defend the slope in its whole length to the bottom of the valley, irregularities of the ground must be taken advantage of ~~by~~ a cross flanking fire. But it is indispensable that the right and left of the Battery be covered by traverses from the fire of the opposite ground, and avoid at the same time being commanded within grape.

The use of traverses being only applicable to works intended to *flank* the bottom of the hill, it may be necessary to dispute the passages by a direct fire, from a Battery half-way down the hill: this can only be done by raising parapets to a sufficient height to cover the carriage in its whole length, so that it can only be seen through the embrasure, which need not be very large, as it is intended to bear on only one passage.—(See Profile No. 1, Field Battery.)

The most expeditious method to form these Batteries is to take the level of the ground for the sole of the embrasure.—(See Profile No. 2.)

The Artillery thus placed in advance will *retire*, after having defended these approaches, through the intervals of the line of position.

If the irregularities in front of the position are not very considerable, instead of advancing down the hill, it will sometimes be sufficient to raise the guns 2 or 3 feet in certain directions (see Profile No. 3), to discover the whole of the slope and see the enemy every where. This will be preferable, particularly when we cannot so advance without subjecting ourselves to command from the opposite heights, which occasions great labour in forming traverses and sinking trenches, to remedy the evil of being commanded at a small distance.

Construction.—Profile.

The Thickness of parapets against musketry need be only 3 or 4 feet.

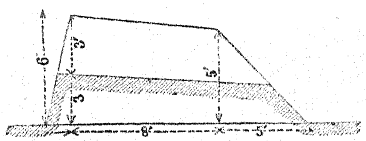
To resist canon at a distance of 1200 paces, 9 feet will be sufficient; and in all cases, and at the nearest distances, 12 feet will resist the nearest Artillery used in the field.

The Height of the parapet above the platform in front of the gun cannot exceed 3 feet, but in the space between it is raised to 4 feet 4 inches;—this relates to ground not commanded.—(See Profile No. 4.)

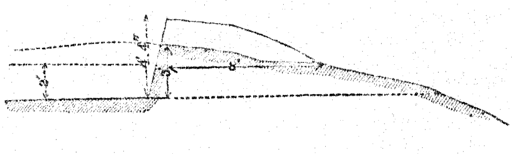
When commanded, the parapet must be raised, or traverses formed, as circumstances may require.

The four following profiles are of the description required in the field for Batteries.

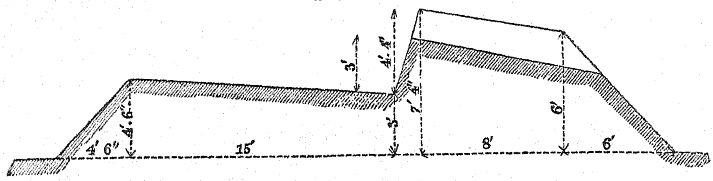
Profile 1.



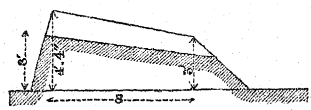
Profile 2.



Profile 3.



Profile 4.



BATTERY TABLES.

In the following Tables no difference is made with reference to labour, tools, and materials in the description of Battery, whether Elevated, Sunk, or Half-sunk; one sufficient allowance being made for all in any soil except hard gravel or rock: 20 feet length of parapet per gun, or 23 feet per mortar, is allowed for each piece; and is taken, with its labour, tools, and materials, as the unit. A like quantity is assumed for each epaulement, and one-third for each traverse, on account of additional labour, &c., in the extra length of parapet it entails, as well as in its own construction: in Breaching and Counter Batteries ⅔rds per traverse is given.

The gun and mortar are placed on the same footing, as the work in the 3 extra feet in the latter may be set against that in the embrasure of the former. Full allowance is made for waste in fascines and sand-bags: the apparently excessive demand for the latter is, however, the result of much experience in the field.

In Gabion Batteries, a full revetment of gabions has been omitted as objectionable; but as there are cases when enough may be obtained for one row on the ground, and the rest completed with fascines, or sand-bags, provision has been made for this in Table II.

BATTERY TABLE I.

DIMENSIONS FOR SIEGE BATTERIES.

	ft.	in.		ft.	in.
Thickness of parapet at top	18	0	Slope of platform . per foot	0	0½
Height of parapet*	7	6	Interior slope of parapet,—from ¼th to ⅓rd height	”	
Distance of embrasures from centre to centre	20	0	Superior slope . . per foot	0	1
Interior opening of embrasure	2	0	Ditto mortar batteries, when reversed . . per foot	0	1
Exterior ditto (= ½ thickness of parapet)	9	0	Exterior ditto mortar batteries, if not revetted, per ft.	1	0
Height of genouillère, for travelling carriage	3	0			
Height of genouillère, for garrison carriage	2	3	Distance of traverse from parapet	2	0
Width of berm	3	0	Length of traverse = that of platform	”	
Depth of ditch	6	0			
Width of ditto at top	24	0	Breadth of traverse at base	7	0
Ditto ditto at bottom	12	0	Ditto ditto at top	4	0
Platform for travelling carriage					
Length	18	0	Length of epaulement,—sufficient to protect the rear of the battery	”	
Breadth	12	0			
Ditto for garrison carriage					
Length	15	0	Mortar platforms, from centre to centre	23	0
Breadth	12	0			

* In Half-sunken Batteries, 5 ft. 6 in. or 6 ft. In Sunken Batteries, 5 ft.

BATTERY TABLE II.

CONSTRUCTION OF BATTERIES FOR THE DESTRUCTION OF THE DEFENCES.

	Labour, Tools, and Materials for Parapet, Epaulements, and Traverses; not including Platforms or Magazines.	Ratio per Gun or Mortar, as the Unit.	2 Guns and 2 Epaulements.	3 Guns and 2 Epaulements.	4 Guns, 2 Epaulements, and 1 Traverse.	6 Guns, 2 Epaulements, and 2 Traverses.
		Unit.	Unit × 4.	Unit × 5.	Unit × $6\frac{1}{3}$.	Unit × $8\frac{2}{3}$.
	FASCINE BATTERIES.					
Labour.	Sappers, or Acting ditto; Revetters . . .	3	12	15	19	26
	Line; Diggers, Shovellers, Rammers, and Assisting Revetters	15	60	75	95	130
	Total labour . .	18	72	90	114	156
Tools.	Pickaxes	6	24	30	38	52
	Shovels	12	48	60	76	104
	Rammers	3	12	15	19	26
	Hand saws	1	4	5	6	8
	Fascine mallets	3	12	15	19	26
	Tracing pickets for embrasures, 4 feet long .	2	4	6	8	12
	Small ditto, per Battery	20	,,	,,	,,	,,
	Crow-bar, per Battery	1	,,	,,	,,	,,
	50-feet tape, per Battery	1	,,	,,	,,	,,
	Field level, per Battery	1	,,	,,	,,	,,
Materials.	Fascines, 18′ × 10″ diam^{r}. Revetting parapet and embrasures	24	96	120	152	208
	Fascines, 18′ × 10″ diam^{r}. Revetting end of each epaulement	(12)	24	24	24	24
	Pickets for ditto, 4 feet long	168	840	1008	1232	1624
	Gabions for traverses, 3 ft. high × 2 ft. diameter	,,	,,	,,	48	96
	SAND-BAG BATTERIES.					
Labour.	Sappers, or Acting ditto; Revetters . . .	3	12	15	19	26
	Line; Diggers, Shovellers, Rammers, and Fillers	18	72	90	114	156
	Total labour . . .	21	84	105	133	182
Tools.	Pickaxes	6	24	30	38	52
	Shovels	15	60	75	95	130
	Rammers	3	12	15	19	26
	Hand mallets	6	24	30	38	52
	Tracing pickets for embrasures, 4 feet long .	2	4	6	8	12
	Small ditto, per Battery	20	,,	,,	,,	,,
	Crow-bar, per Battery	1	,,	,,	,,	,,
	50-feet tape, per Battery	1	,,	,,	,,	,,
	Field level, per Battery	1	,,	,,	,,	,,
Materials.	Sand-bags, 1-bushel. Revetting parapet and embrasures	800	3200	4000	5067	6934
	Sand-bags, 1-bushel. Revetting end of each epaulement	(300)	600	600	600	600
	Gabions, 3′ × 2′ diameter	,,	,,	,,	48	96
	(Sand-bags for traverses, if gabions cannot be had)	,,	,,	,,	600	1200
	GABION* BATTERIES.—UPPER HALF FASCINE.					
	Labour and Tools.—Vide 'Fascine Batteries.'					
Materials.	Gabions, 3′ × 2′ diameter	12	48	60	124†	200†
	Fascines, 18′ × 10″. Revetting parapet and embrasures . .	17	68	85	108	148
	Fascines, 18′ × 10″. Revetting end of each epaulement . .	(12)	24	24	24	24
	Pickets, 4 feet long	119	644‡	763‡	924‡	1024‡
	UPPER HALF SAND-BAG.					
	Labour and Tools.—Vide 'Sand-bag Batteries.'					
Materials.	Gabions, 3′ × 2′ diameter	12	48	60	76	104
	Sand-bags, 1-bushel. Revetting parapet and embrasures	600	2400	3000	4400†	6400†
	Sand-bags, 1-bushel. Revetting end of each epaulement	(300)	600	600	600	600

* Or cask. Beef and pork tierces, or rum hogsheads, give dimensions nearest to those of the gabions.
† Including for traverses. ‡ Including for the ends of the epaulements.

BATTERY TABLE III.

CONSTRUCTION OF BREACHING AND COUNTER BATTERIES.

	Labour, Tools, and Materials, for Parapet and Traverses; not including Platforms or Magazines.	Ratio per Gun, as the Unit.	2 Guns.	3 Guns.	4 Guns and 1 Traverse.	6 Guns and 2 Traverses.
		Unit.	Unit × 2.	Unit × 3.	Unit × $4\frac{2}{3}$.*	Unit × $7\frac{1}{3}$.*
Labour.	Sappers, or Acting ditto	6	12	18	28	44
	Line; as Labourers, according to localities	„	„	„	„	„
	Total labour	6	12	18	28	44
Tools.	Pickaxes	6	12	18	28	44
	Shovels	6	12	18	28	44
	Crow-bars	1	2	3	4	6
	Hand saws	1	2	3	4	6
	Fascine mallets	3	6	9	12	18
	Field level, per Battery	1	„	„	„	„
	50-ft. tape, ditto	1	„	„	„	„
Materials.	Fascines, 18′ × 10″ diameter	7	14	21	33	52
	Pickets for ditto, 4 feet long	50	100	150	231	364
	Sap gabions, 33″ × 20″ diameter, for parapets and embrasures	24	48	72	112	176
	Gabions, for traverses, 3′ × 2′ diameter	48	„	„	48	96
	Sand-bags, 1-bushel	100	200	300	400	600

* Applied in Tools, only to pickaxes and shovels.

BATTERY TABLE IV.

Magazines for 3 Guns, at 240 rounds per Gun. See Plate II.	Magazines. 1	2	3	4
Sappers; Revetters and Builders	4	8	12	16
Line; Labourers to ditto	6	12	18	24
„ Diggers, Shovellers, and Rammers to Magazine	10	20	30	40
„ forming communication with Battery	16	32	48	64
Total	36	72	108	144
Pickaxes	12	24	36	48
Shovels	14	28	42	56
Rammers	3	6	9	12
Mallets, hand	2	4	6	8
Saws, hand	2	4	6	8
Hammers, large, claw	2	4	6	8
Spikes, 6-inch	50	100	150	200
Gimlets to ditto	2	4	6	8
Frame, common to all kinds. Baulks,* 10′ × 6″ × 6″	30	60	90	120
Frame, common to all kinds. Sills, (1 cap and 2 ground,) 15′ × 6″ × 6″	3	6	9	12
Frame, common to all kinds. Stanchions,† 6½′ × 6″ × 6″	5	10	15	20
Frame, common to all kinds. Mining frames and sheeting plank. Bays complete	3	6	9	12
Frame, common to all kinds. Tarpaulin, 17′ × 12′	1	2	3	4
If revetted internally (the back and 1 end) with				
Planks only; planks 15′ × 1′ × 1½″	9	18	27	36
„ 7′ × 1′ × 1½″	7	14	21	28
Fascines only; fascines 15′ × 10″ diameter	10	20	30	40
„ 7′ × 10″ diameter	9	18	27	36
Half fascine, half plank; fascines 15′ × 10″ diameter	6	12	18	24
„ 7′ × 10″ diameter	9	18	27	36
planks 15′ × 1′ × 1½″	6	12	18	24
Gabions only; gabions 3′ high × 2′ diameter	22	44	66	88
Half gabion, half plank; gabions do. do.	14	28	42	56
planks 15′ × 1′ × 1½″	6	12	18	24
Sand-bags only; sand-bags, bushel	450	900	1350	1800
Half sand-bag, half plank; sand-bags, bushel	300	600	900	1200
planks 15′ × 1′ × 1½″	6	12	18	24

* General Pasley mentions 9″×6″; since then, however, the French experiments at Metz bear out the judgment of Sir J. F. Burgoyne, from whom the 6″×6″ scantling is taken as sufficient when covered, as shewn in the transverse section of this magazine.

† Not including tenons. It is assumed that the stanchions, cap sill, and ground sill, are sent with mortises and tenons complete.

BATTERY TABLE V.—Vide Plate III.

Labour, Tools, and Materials, for laying (only) Platforms in Gun and Mortar Batteries.	Scantling. Gun.	Mortar.		Per Gun or Mortar, as Unit.	Guns or Mortars. 2	3	4	6
COMMON OBLONG PATTERN.								
Labour.								
Carpenters				2	4	6	8	12
Labourers, cutting trenches, &c. &c.				2	4	6	8	12
Total labour				4	8	12	16	24
Tools.								
Adzes				1	2	3	4	6
Axes, broad				1	2	3	4	6
„ pick				2	4	6	8	12
Augers, ⅞-in.				2	4	6	8	12
Levels, field				1	2	3	4	6
Rammers, earth				2	4	6	8	12
Saws, hand				2	4	6	8	12
Spades				2	4	6	8	12
Wrenches, screw				2	4	6	8	12
Materials.								
Hurters	12′	„	× 6″ × 6″	1	2	3	4	6
Sleepers	18′	8′	× 6″ × 5″	5	10	15	20	30
Planks	12′	8′	× 1′ × 3″	18* / 8†	36 / 16	54 / 24	72 / 32	108 / 48
Side ribands	18′	8′	× 9″ × 2″	2	4	6	8	12
Screw-bolts (10″ × ¾″) and nuts				10* / 8†	20 / 16	30 / 24	40 / 32	60 / 48

* Gun platform. † Mortar platform.

BATTERY TABLE VI.

MADRAS PLATFORMS.—VIDE PLATE III.

Labour, Tools, and Materials; laying only.	1 Gun or Howitzer.	2	3	4	6
Labour.					
Carpenters	2	4	6	8	12
Labourers, cutting trenches, &c. &c.	2	4	6	8	12
Total labour	4	8	12	16	24
Tools.					
Axes, broad	1	2	3	4	6
„ pick	2	4	6	8	12
Augers, ½-inch	2	4	6	8	12
Hammers, claw, large	1	2	3	4	6
Levels, field	1	2	3	4	6
Mallets, hand	1	2	3	4	6
Rammers, earth	2	4	6	8	12
Screw-drivers	2	4	6	8	12
Spades	2	4	6	8	12
Materials.					
Side pieces, complete	2	4	6	8	12
Trail piece, ditto	1	2	3	4	6
Head piece, or front transom	1	2	3	4	6
Transoms, centre and rear	2	4	6	8	12
Sleepers, 10 ft. long	1	2	3	4	6
„ 8 ft. 3 in.	1	2	3	4	6
„ 6 ft. 6 in., and pivot	1	2	3	4	6
„ 6 ft.	1	2	3	4	6
Iron tie-bolt and nut	1	2	3	4	6
Screws—5-inch: No. 231	24	48	72	96	144

SECTIONS OF SIEGE BATTERIES.

Fig. 1.
Elevated Battery.

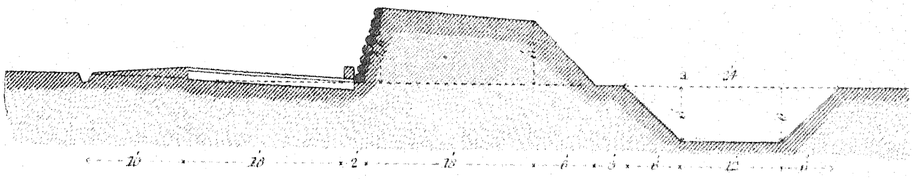
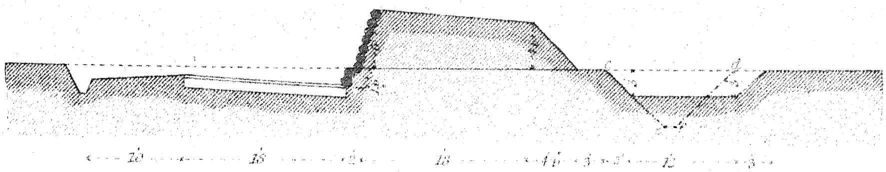


Fig. 2.
Half Sunken Battery.



c d e f Is the Section when 6 Feet deep.
c d = 15½ e f = 1½

Fig. 3.
Sunken Battery.

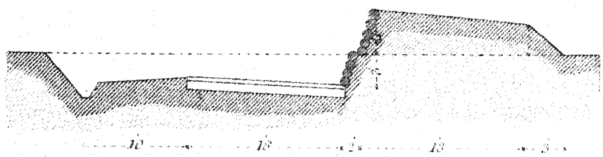


Fig. 5.

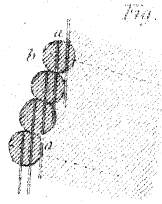
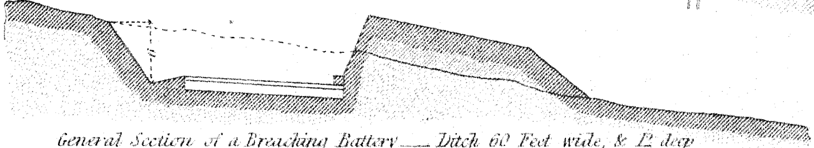
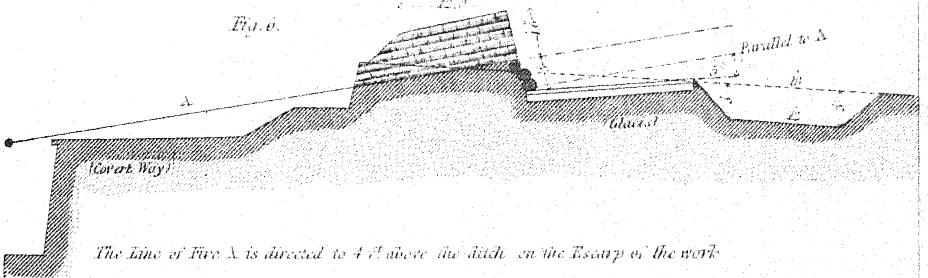


Fig. 4.
Sunken Battery as at Ciudad Rodrigo.
(from Memory)
J. F. B.



General Section of a Breaching Battery —— Ditch 60 Feet wide, & 12 deep

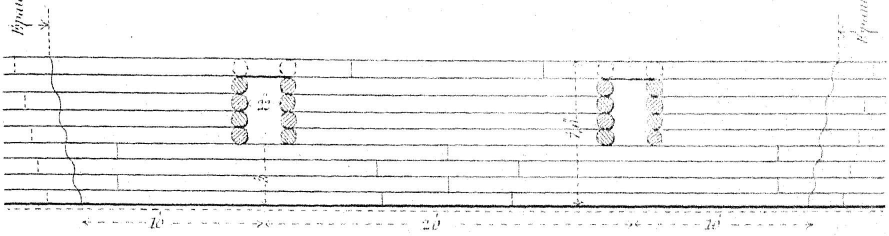
Fig. 6.



The Line of Fire A is directed to 4 ft. above the ditch on the Escarp of the work

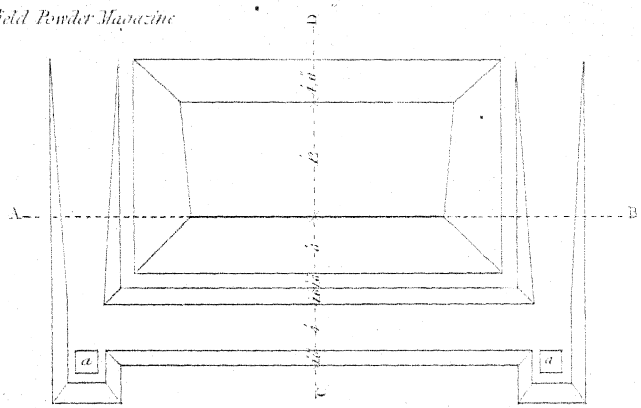
Fig. 1.

Interior of a 2 Gun Battery revetted with Fascines.



Figs. 2.3.4.
Plan and Sections of a
Field Powder Magazine

Fig. 2.



a a Cess-pools

Fig. 4.
Section C D

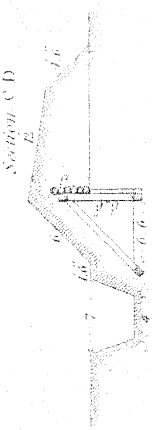
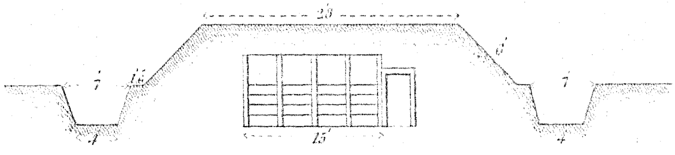


Fig. 3.
Section A.B.



The above Magazine is capable of holding 56 Barrels of Powder.

Fig. 5.

Transverse Section
of a Splinter Proof
Traverse.

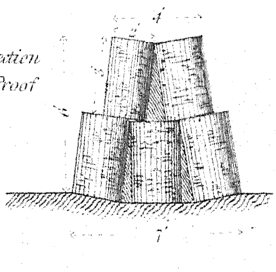


Fig. 6.

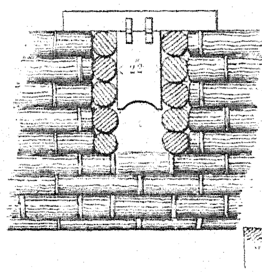
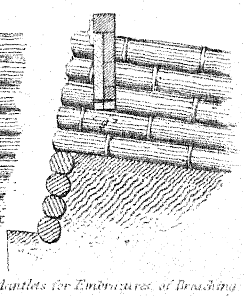


Fig. 7.



Figs. 6.7. Mantlets for Embrasures, of Breaching and Counter Batteries.

Figs 1.2 MADRAS PLATFORM.

Fig. 1.

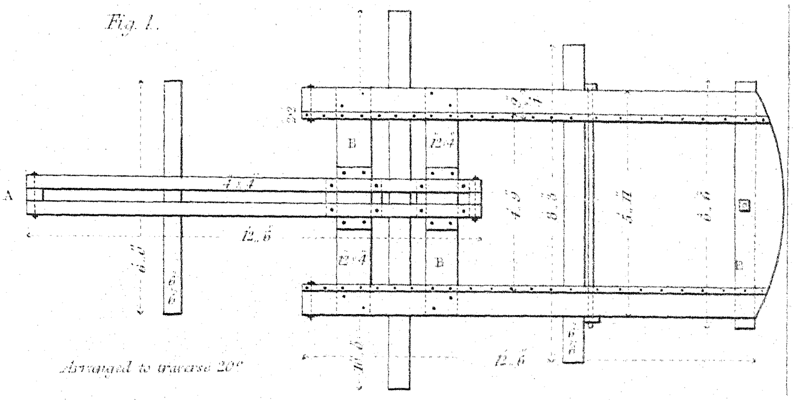
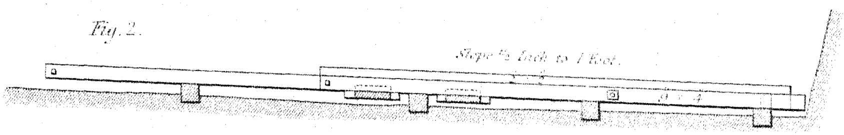


Fig. 2.



Figs 1.2. Gun Platform for Travelling Carriages 24 Pr. or 18 Pr. By removing the Trail Plank A and shortening the Transoms B it will do for Garrison Carriages.

Figs 3.4. COMMON GUN PLATFORM.

(laid with Screws instead of Spikes)

Fig. 3.

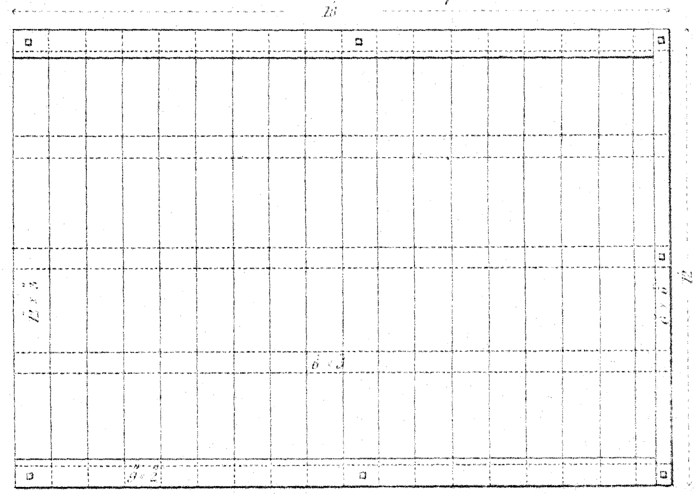
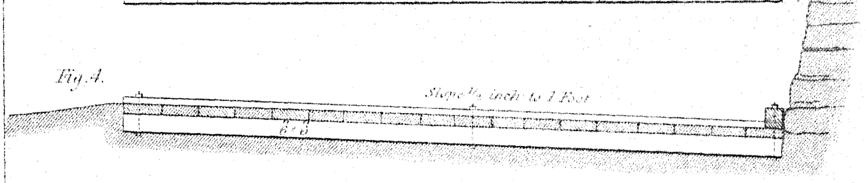
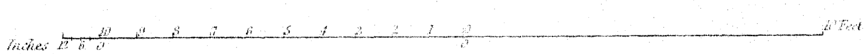


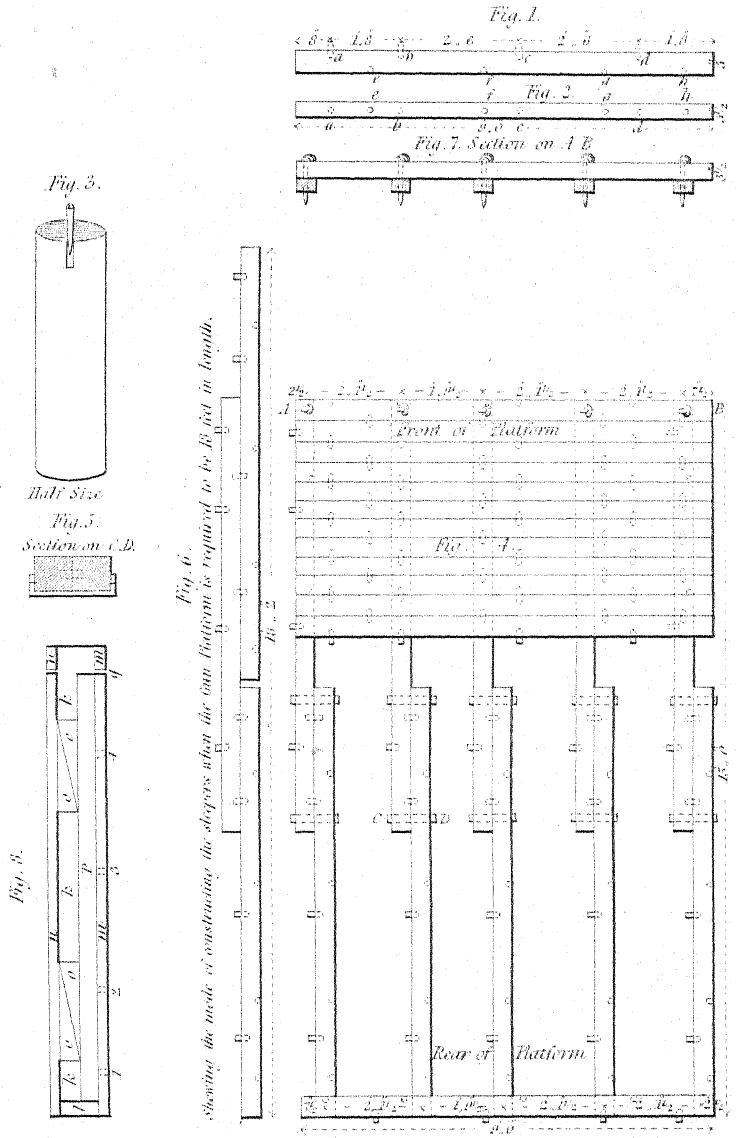
Fig. 4.





SIEGE GUN PLATFORM.

by Lt. Colonel Alderson R.E.



BATTERY TABLE VII.

LIEUT.-COLONEL ALDERSON'S GUN PLATFORM. VIDE PLATE IV.

	Labour, Tools, and Materials; laying only.	1 Gun or Howitzer.	2	3	4	6
	18-FT. PLATFORM, FOR GUNS ON TRAVELLING CARRIAGES.					
Labour.	Carpenters	3	6	9	12	18
	Labourers, cutting trenches, &c. &c.	2	4	6	8	12
	Total labour	5	10	15	20	30
Tools.	Axes, broad	1	2	3	4	6
	„ pick	2	4	6	8	12
	Augers, $\frac{5}{8}$-inch	2	4	6	8	12
	Gimlets (to 1-inch screw)	2	4	6	8	12
	Hammers, claw, large	1	2	3	4	6
	Levels, field	1	2	3	4	6
	Mallets, hand	2	4	6	8	12
	Mauls, pin	1	2	3	4	6
	Rammers, earth	2	4	6	8	12
	Screw-drivers	2	4	6	8	12
	Spades	2	4	6	8	12
Materials.	Joists	54	108	162	216	324
	Dowels	216	432	648	864	1296
	Iron pins	10	20	30	40	60
	Iron shoes	10	20	30	40	60
	Screws to ditto, 1-inch, (No. 205)	20	40	60	80	120

BATTERY TABLE VIII.

LIEUT.-COLONEL ALDERSON'S 8 AND 10-INCH MORTAR PLATFORM.
VIDE PAGE 144.

	Labour, Tools, and Materials; laying only.	1 Mortar.	2	3	4	6
Labour.	Carpenters	2	4	6	8	12
	Labourers, cutting trenches, &c. &c.	2	4	6	8	12
	Total labour	4	8	12	16	24
Tools.	Axes, broad	1	2	3	4	6
	„ pick	2	4	6	8	12
	Augers, $\frac{5}{8}$-inch	2	4	6	8	12
	Hammers, claw, large	1	2	3	4	6
	Levels, field	1	2	3	4	6
	Mallets, hand	2	4	6	8	12
	Mauls, pin	1	2	3	4	6
	Rammers, earth	2	4	6	8	12
	Spades	2	4	6	8	12
Materials.	Joists	27	54	81	108	162
	Dowels	108	216	324	432	648
	Iron pins	10	20	30	40	60

BLINDAGE.

Prior to the Wars of the Revolution, Cormontaingne's section, Plate I. fig. 1, seems to have been regarded as the model.

But the difficulty and expense of procuring such a quantity of $12\frac{3}{4}$-inch baulk as would be required for a tolerably large garrison, and the inconvenience and labour in managing such weighty beams, suggested to M. de Senermont the arrangement given in fig. 2. Though it has not been tested by experiment, those hereafter detailed leave no doubt as to its sufficient strength: it is given here as worth recollection when only scantling can be obtained; but it must be well bridged and stiffened laterally; and it is recommended that about one plank in ten be let a foot into the wall, at each end, as at *o*, fig. 4.

By the experiments at Douay, in 1826–29, it appears that with reference to

HORIZONTAL BLINDAGE,

1st. A single course of naked contiguous beams $12'' \times 12''$, with a bearing of $16\frac{1}{2}$ feet, is *not* proof against shells* on a range of 670 yards; it may stand the first shell, but not a second on or near the same place.

2nd. Neither is such a course of beams secured by a single layer of fascines, brushwood, &c., as no lateral resistance is made to the shell, which easily pierces through this covering.

3rd. But, one such course is perfectly proof when covered by two layers of fascines, crossing each other, (without any earth or dung;) or even by $2\frac{1}{2}$ feet of dung, without fascines.

4th. Also, one course of such beams, 6 inches apart,† is proof, if covered with two of crossed fascines; or one of fascines, and 40 inches of earth; or by a course of baulks $12'' \times 12''$, laid touching each other.

SLOPING BLINDAGES.

Baulks $20' 6''$ long, $12'' \times 12''$, 6 inches apart, and naked, are not proof; neither are they so with one layer of fascines: but they are perfectly so when covered with a course of contiguous beams of the same scantling; or by a bed of earth, from $3' 6''$ to $6'$ thick, as in fig. 4, Plate III.

The Blindages that resisted the shock of the shell were all proof against the bursting; the action of which last seemed much less energetic than that of the shock. This, it is to be observed, is an important principle in the construction of casemates.

Hence, *all* Blindages may be considered proof, made of $12'' \times 12''$ scantling, with a bearing of $16\frac{1}{2}$ feet, if covered with two crossed courses of fascines; or with 3 to 6 feet of earth; or with a second course of contiguous beams, also $12'' \times 12''$. The latter would, however, occasion a great consumption of materials not easily provided.

This conclusion is supported by the fact, that at the siege of Antwerp, in 1832, a mortar battery $18' \times 12'$ in the clear, roofed with one course of $6\frac{1}{2}'' - 7\frac{1}{2}''$ spars, three courses of fascines, and $3'$ to $4'$ of earth,—on side walls of five stanchions $8'' \times 16''$, and 8-inch framing,—stood proof, though struck by many shells; whilst a gun battery, built in like manner, except that no provision was made against the side thrust of the shells, fell at the first blow, and disabled the gun beneath it. There are other

* Size and elevation not given; presumed from the context to be 8-inch shells at 45°, at least.
† An 8-inch shell would find its way through, if farther apart.

precedents and experiments recorded by Dziobek in his 'Taschenbuch,' on the requisite strength for Blindages against 11-inch shells; but there is nothing in contravention of the principles laid down above.

Blindages made with Small Scantling.

The following experiments were also made at Douay:

1. Two courses of 5·6″ × 5·6″ scantling, 20′ 6″ bearing; the pieces 6¾ inches apart, and covered by one layer of fascines, without earth.

2. Ditto, but the pieces in the lower course contiguous.

3. One course of 5·2″ scantling, with 18′ 3″ bearing; pieces touching each other, covered with a bed of saucissons, and 40 inches of earth.

Nos. 1 and 2 were penetrated by shells* at 890 yards.

No. 3 was broken by only two shells out of the fifteen that reached it; hence it is too weak; but the experiment is sufficient to shew that small scantling may be used when larger timber cannot be had.

In the following, the preceding data have been assumed as the basis of construction.

Blindages may be required for Batteries, Magazines, Stores, Hospitals, or Barracks.

When for Gun Batteries, Plate II. gives the details, if behind a full parapet. The side farthest from the enemy only is made splinter-proof by 6-inch scantling, wedged in between the stanchions, as at *c*, fig. 2, and the whole secured by gabions. The struts, *f*, are indispensable to resist the side thrust of the shells. The heart of the outer side, *g*, is built up with dry rubble to relieve the planking from the lateral pressure.

When a Battery is to be placed behind a Barbette Parapet, such as A *c*, fig. 2, Plate III., perhaps only 18 feet thick, there will be some difficulty in forming a face for the height above the low crest, *c*, that would be proof: if formed of ordinary timber, as was done at the siege of Dantzic, (vide Laisné, 2d. edit. p. 421,) and as given in the 'Aide-Mémoire à l'usage des Officiers d'Artillerie,' 1844, it could scarcely be less than 8 or 9 feet thick, and would thus occasion considerable waste. It is therefore best, in this case, to complete the barbette section to that of the full parapet as given in Plate II., by withdrawing 24 feet from the cordon, so as to have 18 feet thickness of parapet and 6 feet exterior slope; revetting the interior of the parapet, and the cheeks of the embrasures, as shewn in figs. 1, 2, Plate III. We are then in the position of Plate I., and the Blindage can be completed exactly as before. The thickness, *d*, *d*, must depend on the fire, either direct or oblique, to which the battery will be exposed.

In Dziobek's 'Taschenbuch' some account is given of a Blinded Mortar Battery used at Antwerp, 1832, but not with sufficient detail to enable a drawing to be made. It would probably be the Gun Blindage, open at both ends, much on the principle of the casemated mortar batteries at Coblenz, which are little more than bomb-proof piazzas.

For Magazines attached to Siege Batteries, vide 'Battery.' When they, or stores, are to be placed in houses for defence of places, dry cellars will be best, properly protected above.

Blindages for Hospitals or Barracks are best made in low strong buildings, with

* Size and elevation, as before, not specified; neither is the nature of the timber: in the account of these experiments in the 'Aide-Mémoire à l'usage de l'Artillerie,' 1844, oak is mentioned; but it is shewn above that the sections, Plates II. and III., are strong enough.

walls, if possible, not less than 3 feet thick, though this seldom occurs but in ecclesiastical or other public buildings, where however the walls are lofty. If a low second story can be arranged under the same cover, so much the better. When Blindages are to be inhabited, the sand, earth, &c., should be kept from falling through by a course of sand-bags, as at *g*, fig. 3, Plate I.

Splinter-proofs, either for hospitals, barracks, or stores, can be made, as in Plate III. fig. 3, wide enough for a man to lay down in, at the rear of the retaining wall of a rampart; or against the counterscarp, on a side not likely to be attacked. When, however, the site can be reached by shells, or when a magazine is wanted, fig. 4, Plate III., is the smallest that can be advisably constructed.

If a building has to be blinded horizontally, as in Plate I., the external abutments can be obtained by running the splinter-proofs or bomb-proofs round it, that will be required for barracks, &c.

The following Table gives some little information as to what is splinter-proof.

Numbers and Range of Splinters, given by French and Prussian Shells, from Experiments.

French and Prussian Denom[ns].	c. 32	pr. 50	c. 27	pr. 25	c. 22	pr. 10	c. 16	pr. 7	c. 15	c. 12
Approx. diam. in English inches.	$12\frac{3}{5}$	11	$10\frac{2}{3}$	$8\frac{3}{4}$	$8\frac{2}{3}$	$6\frac{1}{2}$	$6\frac{3}{10}$	$5\frac{2}{3}$	$5\frac{9}{10}$	$4\frac{3}{4}$
Bursting charge, lbs. . . .	8	$3\frac{1}{7}$	$4\frac{3}{4}$	$2\frac{1}{12}$	$2\frac{1}{10}$	1	1	$\frac{3}{4}$	$\frac{4}{5}$	$\frac{1}{2}$
Number of splinters . . .	22	10—15	18	14—16	33	18—19	21	16—17	22	17
Weight of greatest splinter, lbs.	..	16	..	9	..	$2\frac{1}{2}$	..	2	..	..
Ditto of smallest ditto, oz. .	..	10	..	13	..	5	..	2	..	..
No. of splinters weighing more than $2\frac{1}{4}$ lbs.	22	..	18	..	28	..	17	..	19	14
Extreme range * of splinters, yards	..	750	..	500	..	420	..	350	..	..

R. J. N.

* The French splinters ranged from 650 to 900 yards. In the above, 'c.' is centimetre, and 'pr.' the peculiar mode the Germans have of denominating their mortars and howitzers, which has a very different meaning from our term of 'pounder.' Their 7-pr. howitzer has the same calibre as their 24-pr. gun, of which the shot weighs 24 lbs. Prussian, the 7 lbs. being the assumed weight of a stone ball of the same diameter. The splinters of the 10-pr. and 7-pr. did not penetrate a $3\frac{3}{4}$-inch board, close to them: those of the 25-pr. and 50-pr. did. The nature of the wood is not stated.

Fig. 1.
Cormontaingne's Section

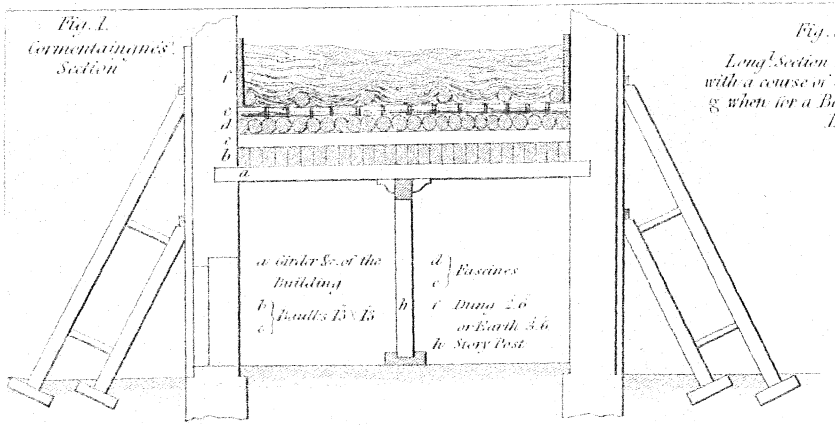


Fig. 2.
M. de Sinermont's improvement on Fig. 1.

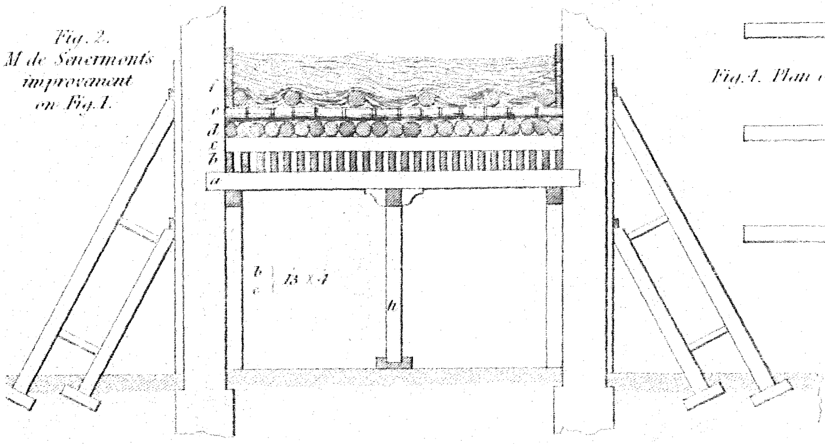


Fig. 3.
Long.l Section of Fig. 2. with a course of Sandbags g when for a Barrack or Hospital.

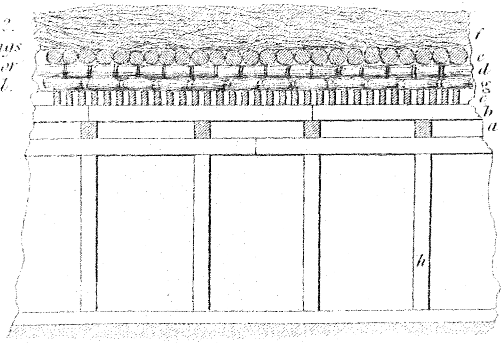
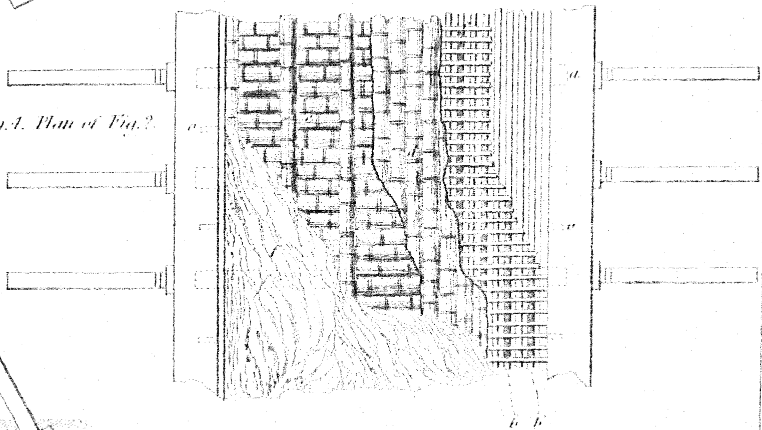


Fig. 4. Plan of Fig. 2.



The darker parts b b are Bridging pieces

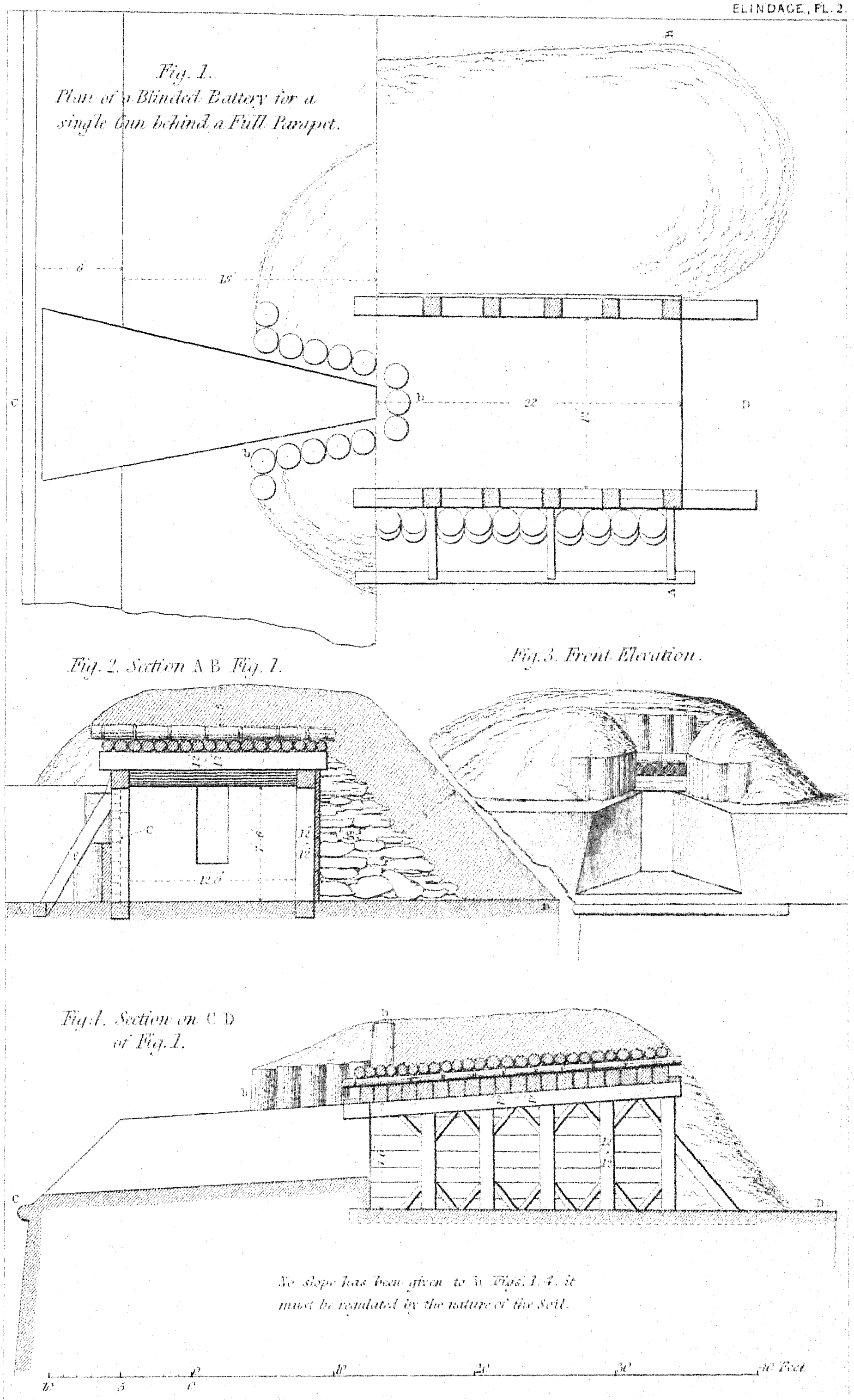


Fig. 1. Plan of a Blinded Battery for a single Gun behind a Full Parapet.

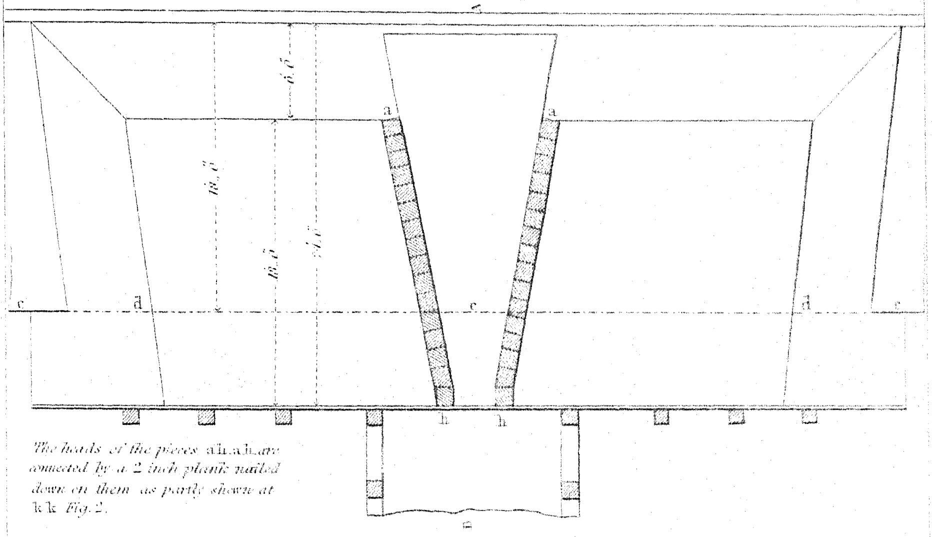
Fig. 2. Section A B Fig. 1.

Fig. 3. Front Elevation.

Fig. 4. Section on C D of Fig. 1.

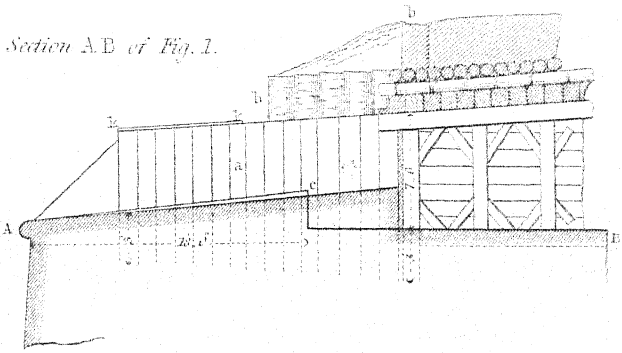
No slope has been given to b Figs. 1. 4. it must be regulated by the nature of the Soil.

Fig. 1 — Plan of a Blinded Battery for a Single Gun behind a Barbette Parapet.



The heads of the pieces a h, a h, are connected by a 2 inch plank nailed down on them as partly shown at k k Fig. 2.

Fig. 2. Section A B of Fig. 1.



No slope has been given to a b in Figs 1, 2. it must be regulated by the nature of the Soil.

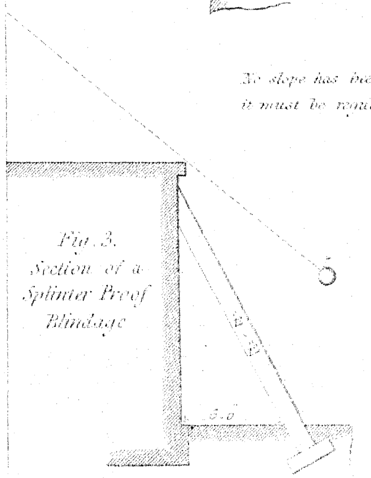


Fig. 3. Section of a Splinter Proof Blindage

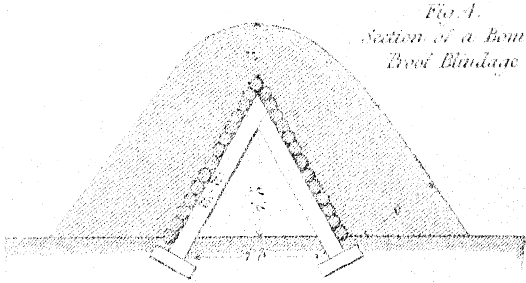


Fig. 4. Section of a Bomb Proof Blindage.

BLOCK.*

WEIGHT OF BLOCKS, AND SIZES OF THEIR PROPER ROPES.

Wood.				Iron.				Metal.				Size of Rope to correspond.
Length of block.	Single.	Double.	Treble.	Length of block.	Single.	Double.	Treble.	Length of block.	Single.	Double.	Treble.	
inches.	lbs.	lbs.	lbs.	inches.	lbs.	lbs.	lbs.	inches.	lbs.	lbs.	lbs.	inches.
26	92·00	142·00	192·00									9
24	67·00	106·00	146·00									$8\frac{1}{2}$
22	57·00	84·00	130·00									8
21	51·00	78·00	108·00									8
20	49·00	72·00	104·00									$7\frac{1}{2}$
18	35·00	56·00	78·00									$6\frac{1}{2}$
17	27·00	45·00	65·00									$5\frac{1}{2}$
15	19·00	34·00	40·00									5
14	16·00	28·00	37·00									$4\frac{1}{2}$
12	10·50	17·00	26·00									$3\frac{1}{2}$
11	8·25	13·00	18·00					9	22·00			$3\frac{1}{2}$
10	6·00	10·00	14·00					8	16·00			3
9	4·50	7·75	9·00	7		17·00	20·00	7	14·00	25·00		$2\frac{1}{2}$
7	2·25	3·75	6·00	6			16·00	6	12·00	18·00		2
6	1·72	2·75	4·50	5			11·00	5	7·00	14·00		$1\frac{1}{2}$
5	1·25	1·50	2·25	4		4·00		4	4·00			$1\frac{1}{2}$
4	·75	1·00	1·25									1

G. B.

BLOCKADE, MILITARY.—As a rule for Blockading a Fortress, and reducing it without a siege operation, and effectually confining the garrison within the works, by a circle of fortified posts, the following narrative of the Blockade of Pampeluna is taken from Sir John Jones's 'Journals of Sieges.'

"The duties of the Blockade were confided to Lord Dalhousie, with the 6th and 7th Divisions of Infantry.

"For the more effectual confinement of the garrison of Pampeluna, and to strengthen the front of the blockading corps, the Marquis of Wellington ordered works to be thrown up all round the place, on the nearest heights favourably situated to command the several roads and communications. Nine redoubts, calculated for garrisons from 200 to 300 men each, were, in consequence, immediately marked out on commanding points from 1200 to 1500 yards from the fortress. The redoubts were ordered to be made of a strong field profile, and to be armed with the French field guns captured at Vittoria, firing through embrasures.

"The investing force furnished strong parties, which worked by regular reliefs throughout the day; but the greater portion of the labour was performed by the peasantry of the country, put into requisition for this service by the Spanish authorities.

"Neither the peasantry nor the soldiers received any working pay; nevertheless, through a vigilant superintendence, and the exertions of the Officers, the whole chain of redoubts was speedily in a state of defence. Garrisons were allotted to the several

* As used in the Navy.

works, which were kept in them constantly prepared to receive and repel any attack; but the remainder of the blockading force was either placed under cover in the villages, or bivouacked on favourable spots just without the fire of the place; the whole, however, being in constant readiness to form under arms at their several alarm posts on the first intimation of the garrison making a sortie.

"In the middle of July, Marshal Soult being in march with a very strong force to the relief of Pampeluna, it became necessary to concentrate all the British and Portuguese forces in the Pyrenees to oppose him; and, in consequence, the blockade was transferred to the Spanish Army of Reserve of the Conde de Abisbal, and subsequently, on the 28th July, was entrusted to Don Carlos de España, with a force of Spaniards not exceeding 8000 or 9000 men.

"Under these circumstances, increased exertions were made to strengthen the several defences of the blockading line.

"Several buildings near the place were barricaded and formed into strong advanced posts; the passage along the roads was obstructed in various places; flèches were thrown up to protect the guards, and signal posts were established to communicate intelligence and orders round the whole blockading circle.

"At the period when the army of Marshal Soult had penetrated to within a few miles of the fortress, and a desperate sortie might naturally be expected, all the advanced posts were reinforced at night, and chains of sentries were pushed out in advance, to guard against surprise on the passage of an individual, and the whole blockading force remained under arms, prepared to repel any powerful effort. These precautions succeeded in preventing a single communication of any kind passing between the garrison and the force engaged for their relief, on the 28th, 29th, and 30th July, almost within view of the ramparts.

"The Blockade of Pampeluna having been well regulated, admitted of no brilliant actions; but the duties and labours of the troops, in consequence of the smallness of their numbers, were, from its commencement to its termination, constant and great. Their vigilance never relaxed for a moment, and in every sortie the garrison was firmly met and quickly repulsed.

"This Blockade is probably a solitary instance of the investment of a large place, situated close to its own frontier, having been so successfully maintained, for the long period of three months, as to preclude the garrison from once communicating with, or receiving intelligence from, their friends.

"On the other hand, the French Governor, Baron Cassan, is justly entitled to the highest degree of praise, for having driven off his submission till the latest possible moment, by inducing his garrison to be satisfied with very slender rations of inferior food; and under such circumstances to perform the duties of a blockaded place, with far more than the usual vigour and activity."

BLOCKHOUSE.—The Blockhouse occupies much the same place in temporary works that the Tower does in permanent fortification: though the former is by no means so secure from destruction, as it may be fired by carcass rockets, or by howitzer carcasses, or rendered untenable by smoke-balls. Hence, the best application for a Blockhouse is as the Keep to a field-work, or in the occupation of a point not easily accessible to the enemy.

In the designs given, therefore, no provision has been made for storing ammunition as if for an independent work, conceiving that a small expense magazine under the

Fig. 1. Plan of Basement.

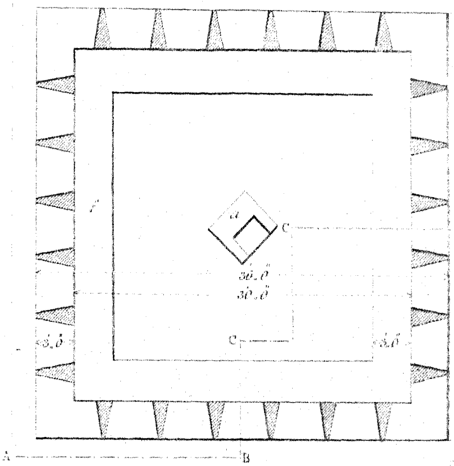


Fig. 2. Plan of Upper Story.

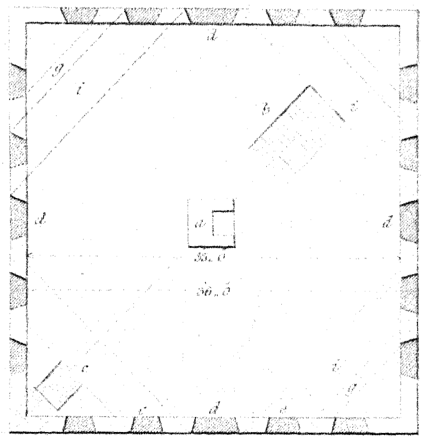
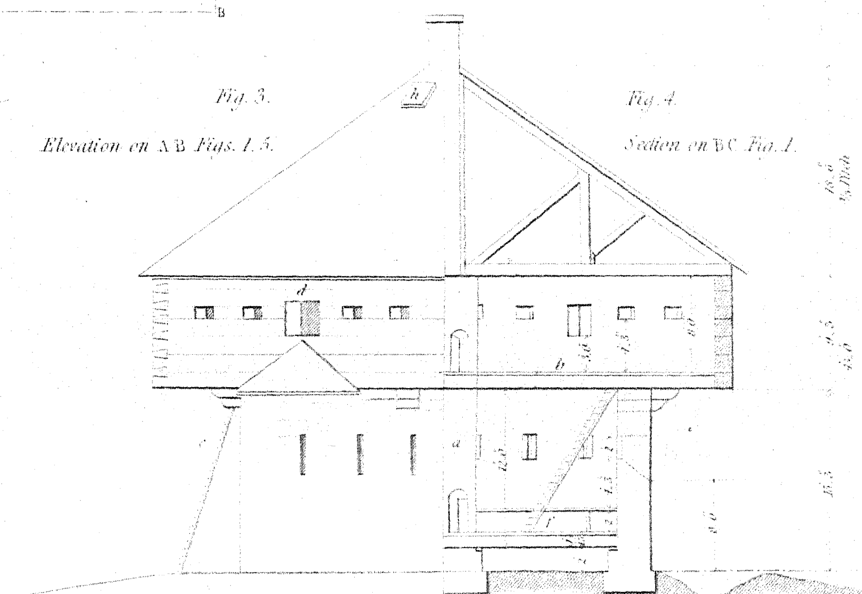


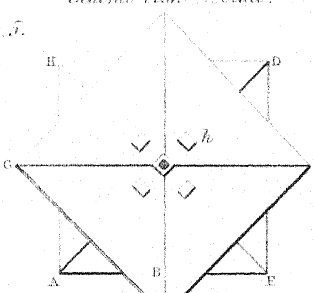
Fig. 3. *Elevation on A B Figs. 1. 5.*

Fig. 4. *Section on B C Fig. 1.*



General Plan ½ Scale.

Fig. 5.



a Fire place.

b Trap hatch & Step ladder to Basement wide enough to let down a provision cask.

c Entrance Step ladder to be hauled up when necessary.

d Embrazures } fitted with Sashes.

e Loop holes }

f Banquette.

g Hinged boards for Machicoulis.

h Smoke Hatches.

i Basement Walls.

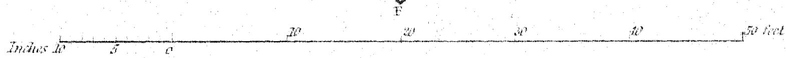


Fig. 1. Plan of Basement.

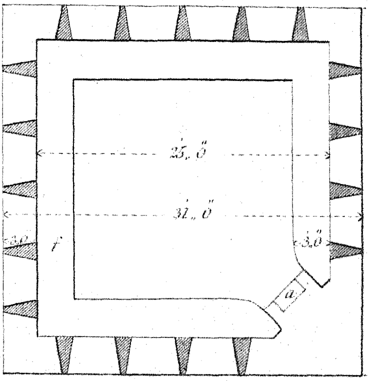


Fig. 2. Plan of Upper Story.

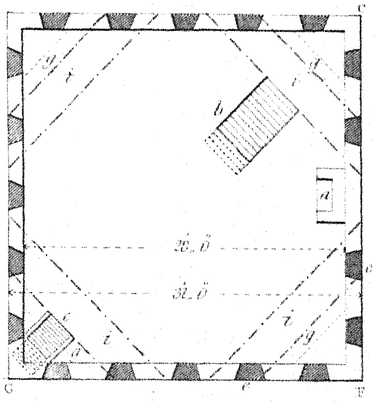
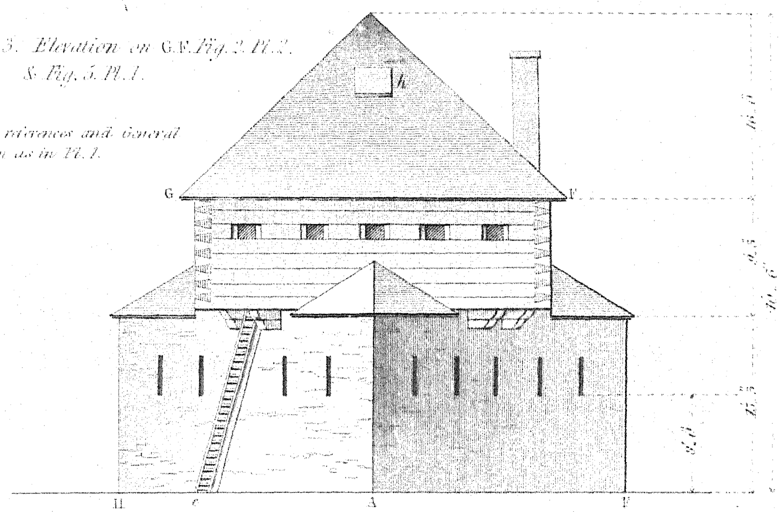


Fig. 3. Elevation on G.F. Fig. 2. Pl. 2. & Fig. 3. Pl. 1.

Detail references and General Section as in Pl. 1.



Figs 4.5. Plan (½ Scale) & Section of a Single Story Blockhouse giving Barrack Room for 70 Men.

Fig. 4.

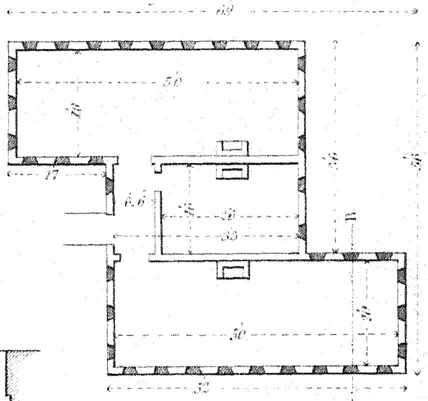
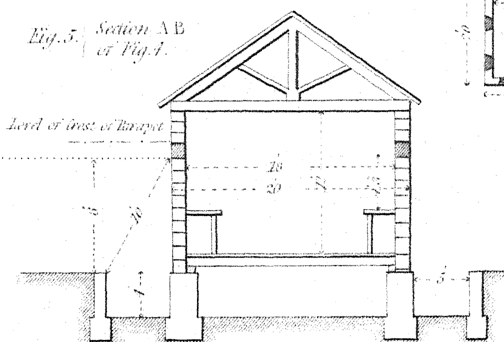
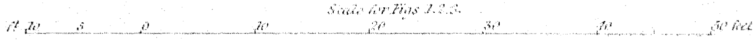


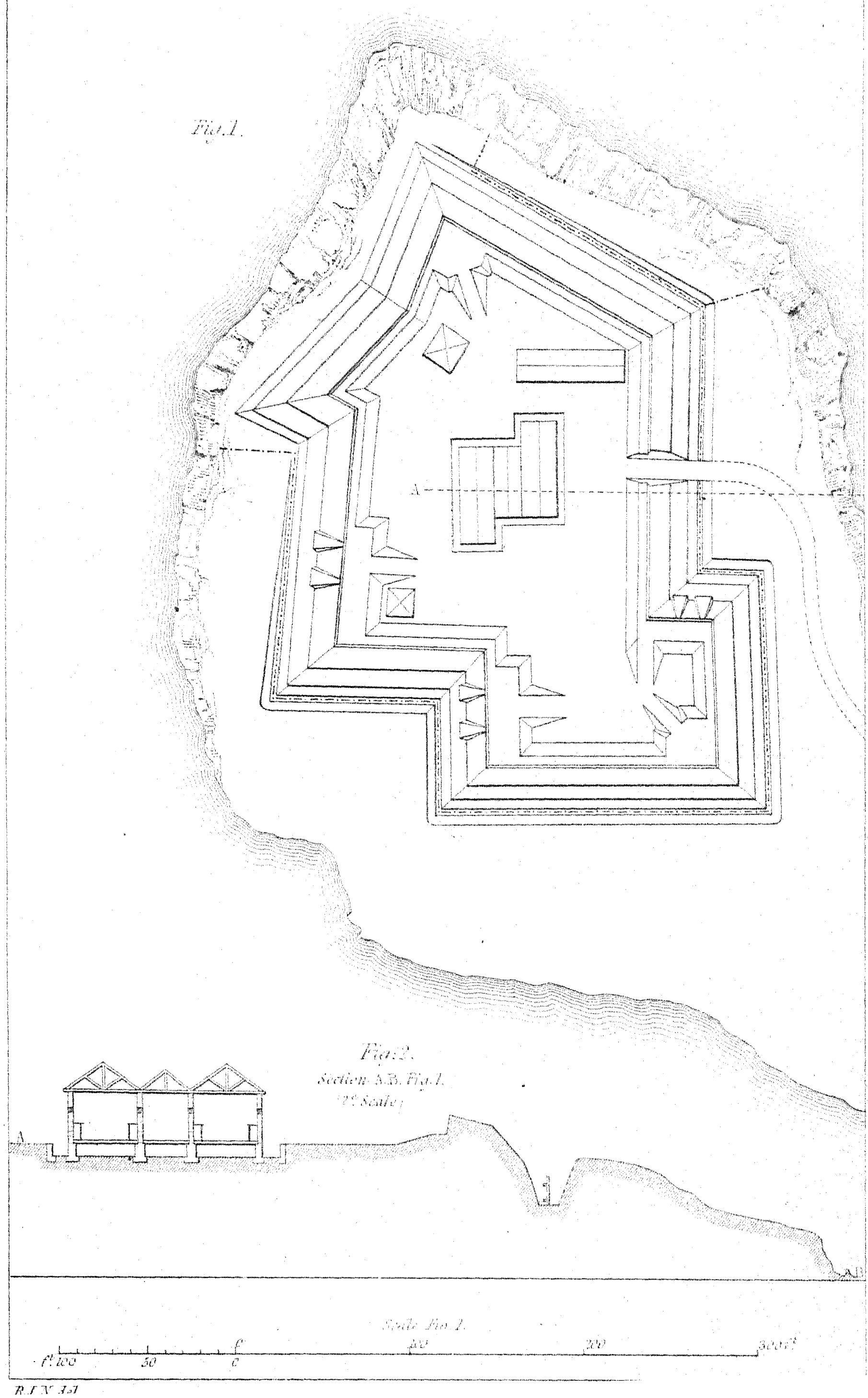
Fig. 5. Section A B of Fig. 4.



Scale for Figs 1.2.3.



APPLICATION OF SUCH A BLOCK-HOUSE AS IS GIVEN FIGS 3. 5. PL. 2.



R.I.N. 3-1

floor will suffice for immediate defence, leaving the basement available as a barrack-room, or as a store generally.

The description of Blockhouse given in Plate I., and in Plate II. figs. 1, 2, 3, has the great advantage over those of the ordinary form* of protecting its salients; and if the hinged planks, *g*, fig. 2, be turned up, a respectable machicoulis is obtained.

In Plate I. the upper story is pierced for 4 carronades or other light ordnance, fitted with breeching as on board ship.

In Plate II. figs. 1, 2, 3, no artillery is supposed to be necessary, but the musketry of the upper story will fire over and extend beyond the work: in figs. 4, 5, the sphere is entirely limited by the works in front, to which it is the keep.

Besides these, however, there are various other forms and constructions; sometimes hexagonal (as at Mondragon, near Guipuscoa, North Spain), with a sunken basement, a ground-floor, and a flat roof with loopholed parapet walls, projecting as machicoulis. The following are the main details of a square American Blockhouse on the Fish River, near the mouth of the Madawaska. Basement, and ground-floor, each 25′ × 25′ in the clear; the former lined with masonry,—the latter, as well as the upper story, of logs, 18″ square in ground-floor, 12″ square in upper story. Height of each story 10 feet; 92 loopholes; roof hipped, with a dormer window on each side; embrasures in upper story, one on each side; stories conformable,—the upper projecting 3 feet all round, as machicoulis, beyond the ground-floor, and thus, 32′ × 32′ within.

When hatches are made in the roof for the escape of smoke, they should be grated, to prevent grenades or combustibles from being thrown in; and when in an exposed situation, the roofs should be covered with zinc, sheet iron, or (as in Canada) with tin.

Windmills generally occupy prominent points of ground; and when large, and otherwise suitable, the lower part may be turned to account as the basement for a Blockhouse.

For the general management in building with logs, vide vol. ii. 'Carpentry:' we merely observe here, that in the largest Blockhouse, the logs can be raised and easily placed in their exact position by a common derrick and guys.—Vide 'Derrick.'

R. J. N.

BOAT.—Under this head are given,—Plate I., Lines for a Ship's Launch; Plate II., Carronade Fitments for ditto; Plate III., Lines for a Four-oared Gig; Plate IV., Lines for a Dingy.

To avoid errors from the small scale of the Plates, the following Tables of dimensions are appended, which have been measured from authentic drawings on a large scale: every thing is given in inches to the nearest quarter.

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* Stories conformable,—upper, projecting as machicoulis all round, beyond ground-floor.

DIMENSIONS OF BOATS.

The Launch.—Plate I.

		⊕	A	B	C	D	E	F	1	2	3	4	5	6	7	8	9	⊕	10*
Vertical Sections.		⊕	A	B	C	D	E	F	1	2	3	4	5	6	7	8	9	⊕	10*
Distances between Vertical Sections.		27·76 in every instance.																	
Horizontal Sections.	⊕	64½	63½	62½	60½	56¼	48	33	64¼	64	63¾	62½	61½	59	56¼	52	46	64½	,,
	a	62½	61	58½	54	46½	35	19	62¼	62	61¼	59¼	57¼	53	46	34½	16	62½	,,
	b	53	51	47¼	41¼	32½	21½	9¼	53½	53¼	51½	48¾	43¾	36½	26½	15½	5	53	,,
Oblique Sections.	V′W	64½	,,	,,	,,	,,	,,	,,	,,	,,	63¼	62¾	61½	59¼	56¼	52	46½	,,	40½
	V′X	70	,,	,,	,,	,,	,,	,,	,,	,,	69¼	67¾	65¼	62	58	51¼	43	,,	35½
	VY	64¾	63¾	63	61	56½	48	33½	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
	VW	72	70¾	69	56	59	50	34½	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,

* 10 is the stern of the boat, not a vertical section.
=
VV′ = 5½
V′a = 32
V′b = 44
V′c = 56
YZ = 29 = WX
Zc = 24

The Four-oared Gig.—Plate III.

Vertical Sections.		⊕	A	B	C	1	2	3	⊕	4*
Distances between Vertical Sections.		⊕ to A 29½	A to B 27	B to C 27		⊕ to 1 29	1 to 2 43	2 to 3 38½		
Horizontal Sections.	⊕	33	31½	27	16	32¼	28¾	21½	33	,,
	a	31¾	30¼	25	12	31¼	25¼	10	31¾	,,
	b	29¼	27½	21	8½	28¼	19¾	5½	29¼	,,
	c	25	22¼	15	4½	23	12	2¾	25	,,
Oblique Sections.	VW	32¾	,,	,,	,,	32	28½	21½	,,	14½
	VX	35¾	,,	,,	,,	35	30	21½	,,	13½
	VY	32¾	31¾	27½	16	,,	,,	,,	,,	,,
	VZ	35¾	34½	29¼	17¼	,,	,,	,,	,,	,,

* 4 is the stern of the boat, not a vertical section.
=
Va = 16
Vb = 21
Vc = 26
Vd = 31
YZ = 12 = WX
Zd = 15

The Dingy.—Plate IV.

Vertical Sections.		⊕	A	B	C	1	2	3	4	5	⊕	6*
Distances between Vertical Sections.		Between 4 and C 17 in every instance.								4 to 5 14		
Horizontal Sections.	⊕	30½	30	27¾	21	30¼	29½	27¾	24½	20½	30½	,,
	a	29¼	27¾	23	14	29	27¾	25¼	20	10¼	29¼	,,
	b	27	24¾	19½	10	26½	24¾	20¾	13¾	5	27	,,
	c	21½	19	13½	5½	21¼	18½	13¼	6½	1¾	21½	,,
Oblique Sections.	VW	30¼	,,	,,	,,	,,	29	27¾	24¾	20½	,,	16½
	VX	34¼	,,	,,	,,	,,	32½	30½	26¾	21¾	,,	17½
	VY	30¼	29¾	28¼	21	,,	,,	,,	,,	,,	,,	,,
	VZ	34¼	33	29	21¼	,,	,,	,,	,,	,,	,,	,,

* 6 is the stern of the boat, not a vertical section.
=
Va = 17½
Vb = 21½
Vc = 25½
Vd = 29½
YZ = 14 = WX
Zd = 12

R. J. N.

DRAWING OF A LAUNCH OF 40 FEET.

	Ft	In
Length	40 .	0
Breadth	10 .	9
Depth	4 .	5

For dimensions, see Table.

Fig. 2. Fig. 3.

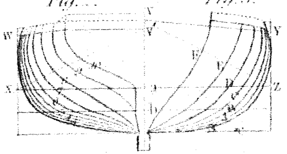
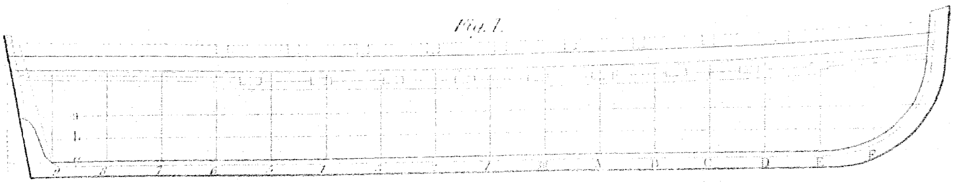


Fig. 1.



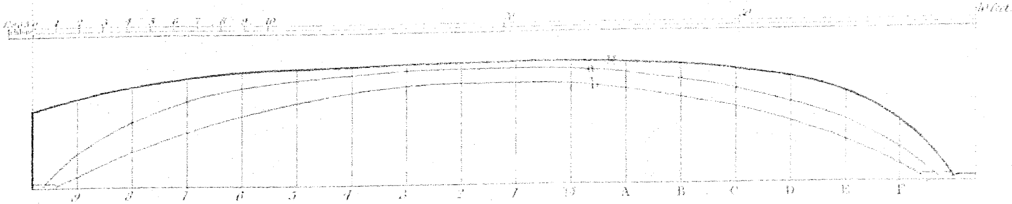
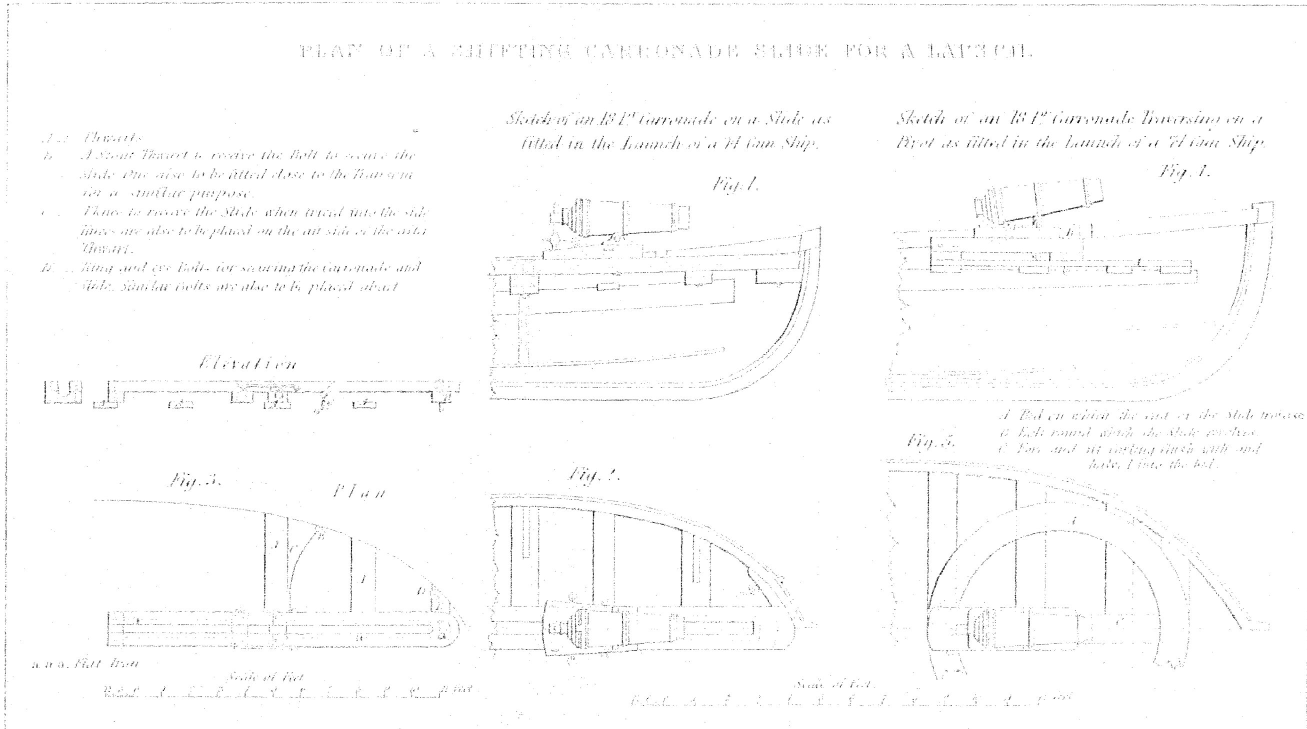


Fig. 4.

N.B. The curve marked 10 in Fig. 2 is the Stern of the Boat and is not a Section. Nos 1 2 of Figs. 1, 4 are not given in Fig. 2.

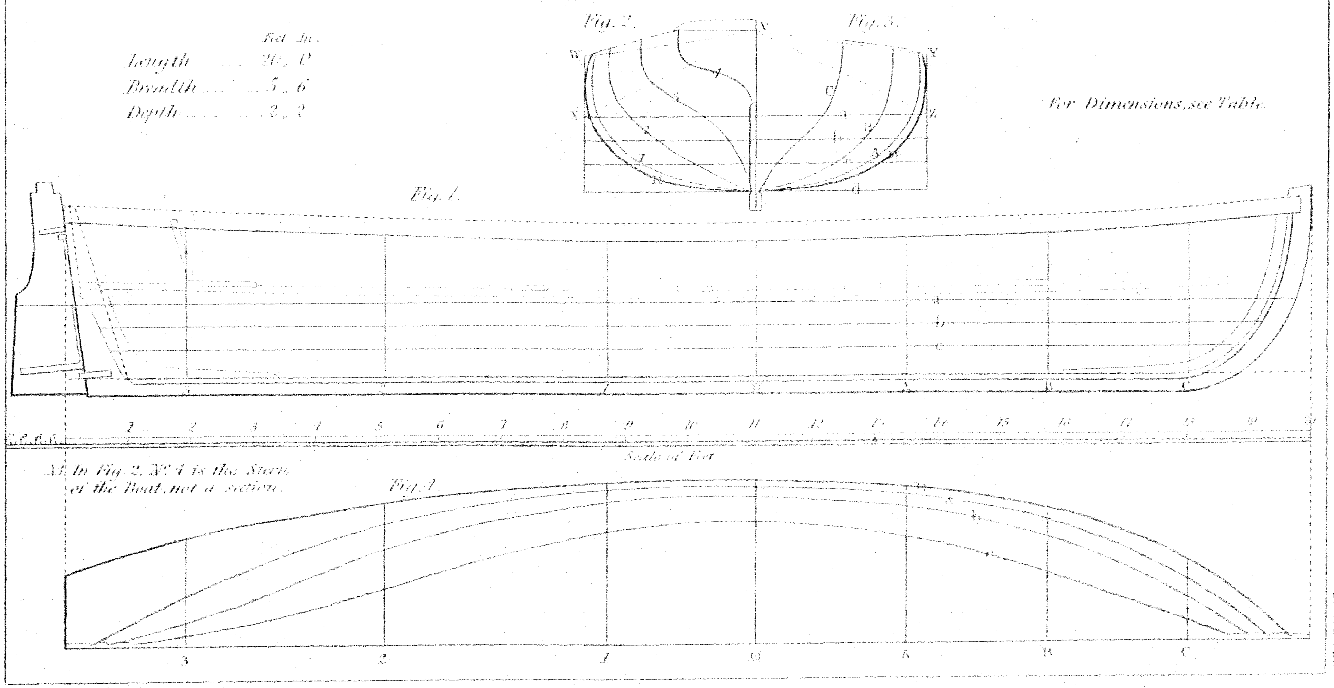
J.W. Lowry sc.

John Weale 59 High Holborn 1844



PLAN OF A SHIFTING CARRONADE SLIDE FOR A LAUNCH.
A.A. Thwarts.
b. A Stout Thwart to receive the Bolt to secure the Slide. One also to be fitted close to the Transom for a similar purpose.
c. Chocks to receive the Slide when traced into the side; these are also to be placed on the aft side of the after Thwart.
d. Ring and eye Bolts for securing the Carronade and Slide. Similar bolts are also to be placed abaft.
Elevation
Fig. 3.
Plan
a. a. a. Flat Iron
Scale of Feet
Sketch of an 18 Pr. Carronade on a Slide as fitted in the Launch of a 74 Gun Ship.
Fig. 1.
Fig. 2.
Sketch of an 18 Pr. Carronade Traversing on a Pivot as fitted in the Launch of a 74 Gun Ship.
Fig. 4.
Fig. 5.
A Bed on which the end of the Slide traverses.
B Bolt round which the Slide revolves.
C Pin and its casting flush with and bolted into the bed.
Scale of Feet.

DRAWING OF A GIG OF 20 FEET.



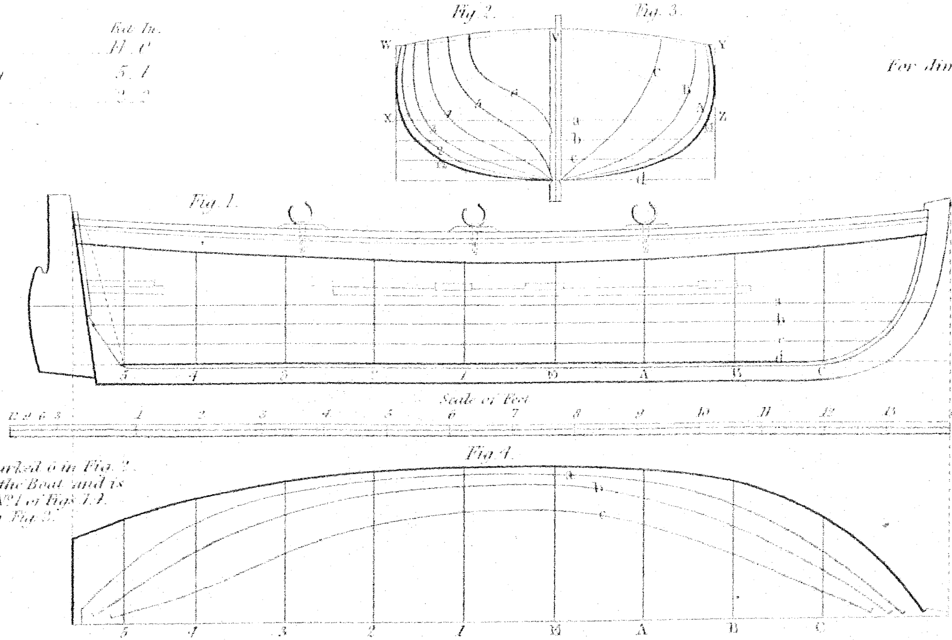
J. W. Lowry sc.

John Weale, 59, High Holborn, 1841.

DRAWING OF A DINGY OF 14 FEET.

	Feet In.
Length	14 . 0
Breadth	5 . 1
Depth	2 . 2

For dimensions, see Table.



N.B. The curve marked 6 in Fig. 2 is the Stern of the Boat, and is not a Section. No. 1 of Figs. 1 & 4 is not given in Fig. 3.

John Weale, 59 High Holborn, 1844.

J.W. Lowry sc.

Note.—It has been found convenient to cut a perfect boat (conformable with Plate III.) in two, athwart, dividing the length nearly into two equal parts,—for the purpose of conveying them more easily over difficult roads,—or from one lake or river to another. The ends are closed by a partition to each part, and are fitted with eyes, through which a bolt or iron bar is dropped. When the two halves are thus joined, they make an excellent boat; and when separate, not a bad dingy.—*Editors.*

BOMBARDMENT.*—"It may be useful to consider the nature and efficiency of bombarding towns, and also the proper employment and real value of mortars in the attack of fortresses.

"To bombard a town is merely to shower down upon it shells, carcasses, rockets, hot shot, and other incendiary missiles, to burn or destroy the buildings, and kill the inhabitants, leaving the fortifications untouched. In a well-constructed place, the military experience few casualties under a Bombardment; they, as well as the powder and stores, being lodged in buildings by their construction proof against the effects of missiles; and consequently, both the garrison and defences are nearly as efficient at the conclusion as at the commencement of a Bombardment. Being so, it is apparent such mode of attack can never succeed, except against a very small place, where bomb-proof cover cannot be obtained; or where the Governor is a weak man, whose sense of duty yields to his feelings of humanity; or that his garrison be insufficient to keep the inhabitants in subjection, under the miseries inflicted on them. The first was the case at Bourbon, where want of shelter, and the apprehension of the principal powder magazine not being fully bomb-proof, were alleged by the Governor as the causes of his capitulating. The two latter apply in their full force to Copenhagen, and at Flushing the attack was latterly prosecuted in the manner of a siege, and the Governor capitulated on account of a breach having been nearly formed in the face of the left bastion; so that casual circumstances alone gave effect to the Bombardment at those places.

"To reduce a place by a regular siege is, in other words, to direct every effort against the fortifications, the garrison, and the armament, leaving the inhabitants and the buildings unmolested. This mode of attack is certain in its effects, but requires that the Engineers should be provided with considerable assistance; whereas, Bombardment is an operation of no Engineer science, and might be carried into effect by the Artillery Officers without Engineers, nearly as well as with them.

"That Bombardment is not availing against a Governor who is firm, innumerable examples might be cited; but suffice three well-known facts.

"In 1757, Frederick of Prussia bombarded the large and populous city of Prague for twenty-two days, in such a furious manner, that the town was nearly destroyed, and the inhabitants suffered so severely, that they rose in general rebellion, and attempted to force the Governor to surrender; but he remained steady to his duty, hung two of the principal Senators, and by his firmness gave opportunity for the battle of Kollin, which obliged the King to retire from before the place. In 1793, equal firmness was shewn by the Dutch Governor of Williamstadt, under a furious Bombardment; and the French, having trusted to mortars alone to reduce the place, failed in the attempt. The third is that of Gibraltar, which was bombarded for two years previously to the attack by the junk ships, in 1782; but who ever heard General

* This Article consists of detached extracts from the Notes of the work on Sieges, by the late Major-General Sir John T. Jones, R.E.

Eliot allude to the sufferings of his garrison from the enemy's shells as a sufficient cause for even thinking of a surrender?

"A strong objection to Bombardment as a general system, is the difficulty of effecting it at a distance from the sea, or the dépôts of a State. Some idea of the great quantity of carriage required to keep up a Bombardment for a considerable time, say 100 days (the town of Landau, with scarcely a bomb-proof in it, resisted a violent Bombardment for 80 days; and the little fort of Andaye for 68 days; and therefore a large place with casemates may be supposed capable of almost an indefinite resistance), may be formed from the facts, that in 1759, Admiral Rodney threw into Havre-de-Grace 19,000 heavy shells, and 1150 carcasses, in 52 hours, to destroy a few boats; that in 1792, the Duke of Saxe Teschen threw into Lille, in 140 hours, without effect, 30,000 hot shot and 6000 shells; that in 1795, Pichegru threw 3000 shells into Manheim in 16 hours, and 5000 shells into the Fort of the Rhine; and at Copenhagen, in 1807, in 3 days of a partial heavy firing, 6412 shells and 4966 shot were expended, besides carcasses; and at Flushing, in 36 hours, the land batteries, and gun and mortar boats, threw about 8000 shot and 4000 shells into the devoted town, besides 5000 shot thrown into it by the fleet.

"On the score of humanity, such a system of attack should be avoided wherever possible. The cruelty of it is inconceivable to those who have not witnessed its effects, which fall chiefly on the aged, the infirm, and the helpless; and it is surely unworthy of a powerful people to seek for success by the destruction of private property, and the mutilation of women and children, when they might command it by a scientific proceeding, harmless to all but those in arms.* It may therefore be useful to make some observations on its employment in the mode most likely to render it efficient which is considered to be an auxiliary to the regular attack.

"In that character, Bombardment can never be otherwise than extremely serviceable; and now that it is fully understood how much the sure and speedy reduction of a fortified place depends on the quantity of ordnance employed in the attack, and how very much the expenditure of ammunition has increased with the strength of guns and mortars, expeditions will be very differently provided from those sent out during the late war; and instead of armies being accompanied with an inadequate battering train, and inadequate ammunition for any species of attack, it is likely Officers in command will request, and the Government willingly furnish, sufficient supplies for both Bombardment and a regular Siege.

"Bombardment might go hand-in-hand with the regular attack. The mortar batteries might be established at distances from 1500 to 1800 yards from the place, to open at the same time as those of the first parallel, and fire over the workmen carrying forward the regular attack. If their fire succeed in inducing the Governor to surrender on the 4th or 5th day of the attack, a most important advantage will have been gained; but if the Bombardment fail of terrifying the garrison into submission, the army will be equally, or perhaps farther advanced in their operations for forcing into the place, than if no Bombardment had been attempted.

"This double operation might be effected without any proportionate increase of labour to the troops, as the works of the regular attack being only 500 or 600 yards

* After the surrender of Ath, in 1745, in consequence of a furious Bombardment from Marshal Saxe, it was urged against the Governor, on his trial, and admitted by him, that only fourteen of his garrison had been killed.

As the slaughter of the inhabitants, and the desolation of the place, are described by eye-witnesses as having been dreadful to behold, some judgment may be formed from this statement of the usually comparative suffering of the soldier and citizen under a Bombardment.

from the place, would naturally engross the attention of the garrison, and the mortar batteries, in their more distant situations of 1500 or 1800 yards, would probably escape observation, or at all events be considered of such minor importance as to be little molested by fire, and might be erected by the peasantry.

"It is, however, to be most particularly understood, that the means of Bombardment must not detract from the means for the regular attack, nor those of the latter diminish the means of Bombardment. There must be no mixture of the operations; each must be kept perfectly distinct.

"Far better will it prove to give the preference to either, and make it powerfully efficient, than to make two weak efforts. Success from either should only be expected from its own full powers to command it.

"A regular attack may, in some degree, be abridged by the skill or boldness of a Commander; but the success of a Bombardment depends altogether upon its own efforts being powerful, unceasing, and maintained in their greatest fury till the proposed effect be produced.

"To bombard a considerable place in a manner really efficient, at least 60 mortars or howitzers should be put in battery, and it would be better that the number were 100. They should fire without intermission throughout the day and night; and, with that view, be furnished with at least 200 rounds each per day. Any increased numbers of mortars used at a Bombardment would not necessarily increase the expenditure of ammunition, as a certain number of rounds fired in three days from 100 mortars, is infinitely more likely to terrify a Governor and population into submission, than the same number of rounds fired in six days from 50 pieces."

VALUE OF MORTARS AT A SIEGE.

"As instruments to be used in furtherance of the regular attack, mortars are, however, highly useful, and, in some cases, indispensably necessary; particularly to search behind and knock down the defensive traverses; to drive the garrison out of their retrenchments, and carry destruction and disorder through every portion of their interior defensive expedients; to tease and harass the guards and tirailleurs, burn the barracks, storehouses, and dépôts of provisions; tear up bridges, break down dams and sluices, explode expense magazines, and annihilate many earthen defences, not to be affected by shot. As weapons of personal annoyance, they are also of great use by their vertical fire, both great and small; for instance, in a confined advanced work, shells from a few mortars will, besides destroying the defences, cause innumerable casualties, if it be kept fully garrisoned; or, if to avoid loss, the enemy keep but few men in it, the work becomes open to assault.

"A few pierriers and mortars, at the siege of Bajados, in 1812, would have had such an effect on the Picurina redoubt; and heavy shells would readily have destroyed the dam of the inundation, and dislodged the defenders from the bridge. Indeed, to attempt to carry on a siege without the aid of mortars, can only be compared to a man volunteering to fight a formidable antagonist with one arm tied up.

"At a regular siege, as well as at every other attack, a judicious mixture of the several natures of ordnance seems to be the proper medium. The proportions of each must vary according to the nature of the attack; but, when battering trains are fitted out without a precise object, it would seem advisable to have one mortar or howitzer with every four guns in large trains, and one mortar with every three guns in small trains, adding one pierrier to every three mortars. It is, however, submitted to the Artillery Officers, if it would not be still better that a proportion of one-pound or half-pound balls should be added to their siege ammunition, in which case mortars of every diameter would be available as pierriers."

STRENGTH OF ARCHES.

"The strength of masonry is far greater in southern than in northern climates;* whilst the concussion produced by the fall of shells, at equal distances, and of equal weights, must be the same in all climates and in all ages: why, therefore, do arches of magazines give way more frequently now than in former wars? It can only be accounted for from the fact, that in the proportion that one shell was fired into a place in those days, we, in our bombardments, throw fifty into a place. Substance is now required much beyond that essential for strength. It is not sufficient that an arch have all the requisite proportions to resist the shock of the heaviest shell, and the piers a force to bear it up, or the roof a pitch to keep it dry; it must also have bulk over it, to admit of the repeated abstractions of substance, caused by numerous shells striking it in rapid succession. Each shell blows away a portion of the covering of the arch, and if their fall be so continuous as to prevent fresh covering being laid on, they speedily penetrate to the masonry; after which each shell carries away 2 or 3 inches thickness of the brick-work, and in a few rounds the equilibrium of strength of the arch is destroyed. As soon as that is effected, a shell striking any part of the surface, shakes the arch through and through, and after a time it is shaken down.†

"That a bomb-proof arch should be kept extremely well covered, is therefore fully as important to its resistance, as that sufficient dimensions be given to the arch itself. Officers in future must take precautions against the increased use of Artillery of the present day, and no longer trust to dimensions derived from the experience of the wars of Louis XIV. *In small places, like Fort Bourbon, no magazine should have less than* 8 *or* 10 *feet of masonry and earth over its arch;* and every Governor, during a Bombardment, ought most sedulously to enforce the immediate restoration of every portion of earth blown away by the fall of shells."

BOOM.—The consideration of this subject becomes important from the increased necessity of guarding against the sudden attacks of steamers, upon rivers and harbours, especially at remote points.

Booms may be applied either to bar access to a harbour or river; or to cut off the retreat of the enemy, should the entrance have been effected by surprise.

Like Abattis, Palisading, &c., before field-works, Booms should never be left unprotected, and should be immediately under fire of a battery, or of a man-of-war, and its guard-boats on the look-out.

It is conceived that the most effectual check to a ship's progress would be given by the partially elastic opposition of hemp cable Booms; but, as these are liable to be quickly destroyed,‡ those of chain, floated by logs, and moored as occasion requires, seem to be most advisable, at least for the exterior line, reserving hemp, if admissible, for those in rear. It is unsafe to trust to a single line of Boom in the main channel: a chance or a well-directed shot, or the impetus of the vessel in unusually strong

* The Author once had in his possession a memorandum made on the spot by an Officer, that an arch of 18 feet span and 2 feet 9 inches thick, without any covering, resisted two shocks of 13-inch shells successively, at the siege of Fort George, in Minorca.

† A heavy shell, falling on a bomb-proof arch well covered with earth, has been known to cause such a concussion as to make wine-glasses jump off a dinner table in a casemate, without injury to the arch.

‡ 'A carpenter's mate—a hand saw and a lump of grease,'—formed a standing part in arrangements for cutting out vessels in the late war, when hemp cables were commoner than those of chain.

winds and tides, &c., &c., may defeat the best calculations of sufficient strength; but, with the check received from the first, if at all adequate to its duty, it would be scarcely likely for any vessel to have way enough to break a second, or, at most, a third, which should be placed at short distances, say from 50 to 100 yards apart in rear,—or perhaps only sufficient for two large boats to row past each other freely.

Even when there is no perceptible rise and fall of tide, a Boom must not be strained too tightly, as the 'passive resistance' of the dead weight of the slack portion would be lost. On the other hand, if too loose, the vessel will easily pass over it.

Generally speaking, the allowance necessary for the rise and fall of tide will give sufficient play. In figs. 1, 2, where a length of Boom of about 300 yards has been assumed, and where, as in figs. 3, 4, 5, there may be a rise and fall of 18 feet in a depth of 100 feet, there will be upwards of 50 or 55 feet between the extreme positions of the Boom at ebb *a*, *a*, and young flood *b*, *b*.

Booms need not necessarily extend entirely across an entrance; shallow or otherwise inaccessible parts may be omitted, or else blocked up by much lighter chains than are necessary for the main channel. A trifle will keep out a gun-boat,—not so a first-rate, or a large steamer. A Boom may be kept constantly down, in whole or part, as the urgency of the case requires. Not to impede the navigation unnecessarily, the 100 yards over that part which will be deep enough for vessels entitled to enter, can be withdrawn to either side entire; or to both, in halves, ready to be replaced, *d*, figs. 1, 2.

To give perfect facility for throwing a Boom across at any moment, an express establishment will be necessary, according to the extent of the obstacle, of—

1. A party familiar with the operation.
2. Housing for these; and for stores when not immediately wanted.
3. Protection for both—afloat and ashore, including guard-boats.
4. Moorings;—a distinct charge from the above, generally devolving on Harbour Masters.

The first three will be disposed of at once, if a man-of-war be specially assigned to this duty; or, at all events, a hulk, not only armed, but fitted with the common arrangements of timber ships, or breakwater vessels, for readily passing out the logs, chain, &c., &c. If anchored near the opening, it would probably afford all the protection that could be required, as well as many facilities for general harbour duties, and the Police and Revenue Services. The timber can either be rafted, moored, and left afloat; or else stowed away below. This sort of provision is the least expensive, so much being left available when no longer required for this service. It is best suited for the defence of small ports. But, if from the importance of the harbour or river, or other causes, an establishment must be made ashore, it will probably amount to a small barrack, store-sheds to receive the boom, boat-house, battery and appointments complete, and perhaps a small floating dock, or a pier, should it be necessary to keep the Boom afloat, and in readiness.

The moorings, at perhaps 100 yards laterally apart, will have nothing peculiar: the buoys must be solid, as in a dark or misty night they are easily scuttled as usually built; the Boom must be quite independent of these last as to buoyancy.

DETAILS OF CONSTRUCTION FOR CHAIN BOOMS.

It is here assumed that it is to be a continuous chain, supported by wooden floats of sufficient buoyancy to offer some resistance to the whole being readily submerged; and of such a shape as shall not expose a flat surface abruptly to the waves.

The cheapest materials will be condemned masts, and the larger yards and spars of men-of-war, cut into suitable lengths, as short as may be convenient, and with inter-

vals not exceeding 3 feet; so that should any one piece be carried away, no very large chasm may be made by the drooping of the unsupported part. The chain should be attached to these junks of masts by *very* strong staples, well secured, alternating with small chain lashings; for if this be at all feebly done, it will be a weak point at which the very shock may destroy all, without a single thing being broken or disturbed, except the staples or other fastenings being started.—(See fig. 7.)

When a Boom is to be a permanent affair, and no old masts are to be had, it may be advisable to build solid cylindrical floats, well hooped, of the required dimensions, just as masts are constructed.

When of a temporary character, and the sacrifice of material is to be avoided, square baulks, lashed together with chain, instead of being hooped, may be substituted for the above.—(See fig. 9.)

In estimating the shock to be expected, it must be remembered, that sailing vessels are not now likely to run into such a cul-de-sac as a harbour, though they may venture through a river or a strait, with open sea at both ends. Hence, in the present day we must calculate as for steamers. Our largest men-of-war of this description may be taken at 1000 or 1200 tons burthen; and this, with a velocity of perhaps 15 knots, would snap any *chain cable*, as made at present, where the largest are only of 2¼-inch round iron; and unless the next such line be very near, it would demolish that readily, as a steamer recovers way, even if entirely stopped by the blow for the moment, in a manner that other vessels cannot do.

For such extreme cases, it is conceived that nothing less than the large and massive mooring chains, of at least 3-inch square iron, has a chance of success; and if the 2nd or 3rd lines are pretty close, even so large a vessel may be staggered, and embarrassed for a sufficient length of time to enable her machinery to be destroyed from the protecting batteries.

The selection of any intermediate sizes between such a Boom, and that only sufficient to keep out boats or small steamers, must depend on the importance of the harbour or river; as well as on the draught of water determining the size of the steamer that can enter.

Fig. 7 shews a Boom as proposed to be made out of old masts. When built expressly, the hoops and staples can be made in one (fig. 8). To support a mooring chain of 2′ 6″ links, 3″ square iron, properly, the diameter, if of yellow pine, ought not to be less than 36 inches.

If the square form be decided on, a side of 32 inches will be required (fig. 9); the lower baulk alone need have staples or clamps. The chain used as lashing will do no injury to the wood, and any degree of tightness and compactness can be given by means of wedges.

Fig. 10 is a baulk siding, 18 inches, as necessary for the largest class *chain cable* made at present.

Booms for small rivers, to protect pontoon bridges, &c., or to obstruct navigation, are easily made on the above principles, except that, should the vessels on the river be of light draught only, and no serious attack be apprehended, logs of wood, connected by short chains, and couplings well let in and secured, will probably be sufficient. Whether the Boom is to go directly across the stream, or to do so obliquely, so as to reduce the strain, will be determined by localities, and the strength of the materials available.

A line of palisading is sometimes used to close a river. It is rarely advisable, and very expensive, especially if only for temporary purposes; for if it be mere palisading in bays, hanging on ribands, it can be easily cut through in the night: but if the main posts or piles be at all near enough to prevent boats from passing, they will, in

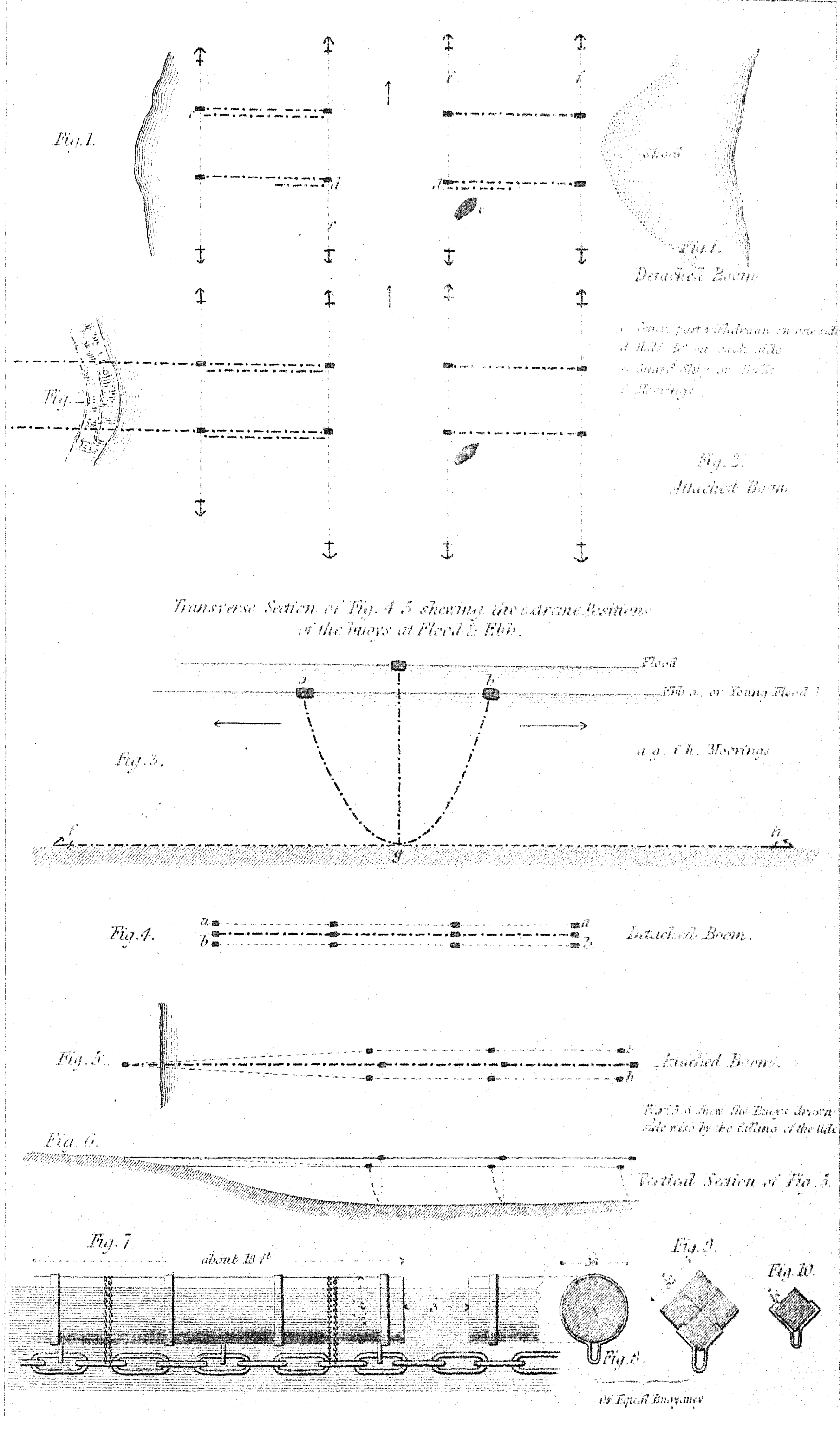


Fig. 1.
Shoal
Fig. 1.
Detached Boom
c Centre part withdrawn on one side
d Half D° on each side
e Guard Ship or Hulk
f Moorings
Fig. 2.
Fig. 2.
Attached Boom
Transverse Section of Fig. 4 5 shewing the extreme Positions of the buoys at Flood & Ebb.
Flood
Ebb a. or Young Flood b.
a g. f h. Moorings
Fig. 3.
Fig. 4.
Detached Boom.
Fig. 5.
Attached Boom.
Fig. 5 6 shew the Buoys drawn side wise by the falling of the tide
Fig. 6.
Vertical Section of Fig. 5.
Fig. 7
about 18 ft
Fig. 8.
Fig. 9.
Fig. 10.
Of Equal Buoyancy

most cases, and in no great length of time, by accumulating mud, sand, &c., form impediments to navigation not readily removeable.

HEMP CABLE BOOMS.

The buoys, moorings, and general arrangements remaining as before, the slight assistance necessary to support the cable will be best given by spars of moderate scantling, which add to the strength in a way that is not done by casks or small buoys. When from necessity casks—always liable to damage—are used, care must be taken not to expose their ends to the sea, or they will soon be destroyed.

R. J. N.

BREACH, as effected by Artillery.—No precise rule can be given either as to the time or ammunition required to make a Breach. The best precedents within reach are therefore given, leaving their application to circumstances.

The two most recent and complete examples are those given by the French experiments at Metz, 1834; and in their siege of Antwerp, in 1832. They differ considerably; chiefly, perhaps, from the latter having been conducted under fire, and the former, (like our experiments against Carnot's Wall,) at leisure and undisturbed; especially as they were made against a fine specimen of Vauban's masonry, which could scarcely have been surpassed by any thing at Antwerp.

	Guns.	Width of Breach. feet.	Shot and Shell.	Distance. yards.	Total Time. hours.
Antwerp .	6 24-prs.	80	1288	55	34
Metz.	4 24-prs.	72	256*	35	8†
	4 16-prs.	75	325*	33	9½†

The best representation of the variable effects of Breaching Batteries is given by Capt. Denison, in vol. ii. p. 38, Corps Papers.

	Width of Breach. feet.	No. Shot.	Distance. yards.	
1812.—Christoval	15	1,600	450	
Badajos, main breach . . .	180	14,000	540	
„ flank ditto . . .	100	9,500	530	Wall casemated.
„ curtain ditto . .	40	3,000	545	Bad masonry.
Ciudad Rodrigo, main ditto .	105	6,700	560	
„ lesser ditto .	30	2,080	570	Bad masonry.
1813.—St. Sebastian.				
main breach . . .	100	13,000	620‡	Good masonry.
lesser ditto . . .	30	5,000	620‡	Ditto.
addition to breaches	330	41,000	520‡	Ditto.
	930	95,880	4955	

* Including forty 8-inch shells each Breach.
† Total time, including that probably required for exchanging guns for howitzers.
‡ Average distances. The quality of the masonry from a R. E. Officer engaged in the siege.

Hence, and from the preceding, as well as from the 'Observations' of Major-General Sir J. May, R.A.—

	Average No. Guns.	Total Width of Breaches.	Mean Distance of Batteries.	Time.	No. Shot per running ft. of Breach.	
		feet.	yards.	hours.		
Badajos	26	320	540	104	83	Brass and Iron Guns. } Bad masonry.
Ciudad Rodrigo . . .	28	135	565	$32\frac{1}{2}$	65	Chiefly Brass. } Bad masonry.
St. Sebastian * . . .	20	130	620	62	139	Iron Guns. Good masonry.
These, proportioned to 10 guns and 100 feet of breach, become—for						
LONG RANGES.						
Badajos	10	100	540	85		
Ciudad Rodrigo . . .	10	100	565	$67\frac{1}{2}$		
St. Sebastian . . .	10	100	620	$95\frac{1}{2}$		
A. General average . .	10	100	575	83	92	
SHORT RANGES.						
B. Antwerp	6	80	55	34	16	Brass Guns. } Good masonry.
C. Metz (average) . . .	4	74	34	$8\frac{3}{4}$	4	Brass Guns. } Good masonry.

Here we have, probably, two extremes (A, C,) and a mean (B) of practice. The Peninsular cases were effected under many disadvantages; the Metz experiments under none; the Antwerp Breach under almost normal circumstances, and gives what may be fairly expected, in short ranges, on Service: it corroborates also the judgment of Bousmard, who specifies about 36 hours† as the time necessary. Where the rubbish cannot be well cleared away from the Breach, as in wet ditches, and other cases, the horizontal groove may be cut at one-third or one-half height of escarp from the bottom; it being remembered that such sized debris gains about two-thirds in bulk from being reduced to that shape from the solid form. But, if it can be removed, the groove should not be more than 3 or 4 feet above the ditch, to insure a readily practicable Breach.

The experience at St. Sebastian in 1813 is opposed to the conclusion from the Metz experiment, that firing by salvos is virtually impracticable: it was done at that siege, even by the ship guns in battery, to all practical purposes; and if detonating locks be used, there remains no doubt on the subject.

Capt. Denison observes, at the end of his Paper referring to the Peninsular Sieges, —the Woolwich experiments on Carnot's Wall, and those at Metz,—"From the

* Referring only to the 'Main' and 'Lesser' Breach:—the 'addition to the Breaches' is rather too vague for even this sort of computation.

† When the old French writers speak of four days to form a Breach, it must have been with brass guns, which, at that time, could hardly be fired oftener than four rounds per hour,—even to the opening of the Revolution, when the attention of the Government was first drawn to that subject. The disparity of power between large and small brass guns, as to standing rapid and long-sustained firing, is very remarkable

At Ciudad Rodrigo and Badajos, 13 rounds per hour were averaged with brass guns. At Metz, 12 per hour. At St. Sebastian, with iron, 20 per hour. Hence Bousmard's 36 would probably be 26 with iron guns.

foregoing it appears, that a Breach about 100 feet wide may be rendered practicable at a distance of 500 yards by the expenditure of about 10,600 24-lb. shot, firing at full charges; that, from about the same distance, it requires 5600 68-lb. shot, and 4200 8 and 10-inch shells, à ricochet, to make a Breach of the same width when the scarp is covered by a counter-guard, as proposed by Carnot; and, that from a battery on the crest of the glacis, about 310 24-lb. shot, and 30—40 8-inch shells, will produce the same effect. The weight of shot, therefore, expended in forming a Breach under these different circumstances will be as follows:

	Width of Breach. feet.	Distance. yards.	Fire.	No. Shot.	No. Shells.	Total weight of Iron. lbs.
Peninsula	100	500	Direct.	10,600	"	254,400
Carnot	100	500	Ricochet.	5,600	4200	660,100
Metz	74	50	Direct.	310	40	9,040

"The disproportion between the direct and ricochet fire would have been more glaring still, had guns of the same calibre been used on both occasions; for the effect of one 68-lb. shot would be far greater than that of three 24-lb. shot, fired at the same angle; and the 8 and 10-inch shells used in the ricochet practice were probably more effective than shot of the same weight."

To effect a Breach by mining in a masonry revetment occasions an expenditure of time and labour not always rewarded by a good practicable Breach, as the explosion generally brings down the escarp in masses difficult to scramble over. This mode of procedure must depend on questions of locality, time, and means, and the facility of attaching the Miner. In earthen ramparts, mud walls, and walls as usually constructed in the East, it is in many cases the only practicable method of making a Breach.

R. J. N.

BRIDGE, PERMANENT.—*Vide* vol. ii.

BRIDGE, FIELD.—Blanshard's Cavalry and Infantry Bridges;—Boat;—Rope;—Boat and Rope;—Cask;—Trestle;—Raft;—Pile and Spar;—Flying, Pivot;—Flying, Trail;—Reconstruction and Demolition.

It is on the above that memoranda are presumed to be most acceptable; omitting many minor contrivances alluded to in foreign works, which circumstances of time and place would suggest to very ordinary ingenuity: as it is, the above series includes even Ferries.

Whatever Bridge system may be under consideration, either for introduction into the Service, or for selection in the field, the following will be amongst the guiding points in determination.

General applicability.	If available as rafts, boats, &c., besides serving as a bridge.
Simplicity of character.	So that its management may be easily learned by all troops.

Capability of rapid construction.

Security from destruction by the enemy.	From peculiarity of construction in detail; or from its general arrangement.
Ultimate buoyancy.	
Stability.	
Height of superstructure above water.	As illustrated below,* with regard to the most probable elementary forms proposed for buoyant bodies.
Ease of management and motion on water.	Implying also lightness, and suitability for speed in rowing as a raft, boat, &c.; capability of movement as a quadrant of conversion.
Facility of detail, construction, and repair.	As requiring only such material and workmanship as is most likely to be at hand.
Security from destruction by natural causes.	Strength to oppose the violent action of wind or water; little liability to split or warp from heat or ice; or to spoil in store, or in use, by the general action of heat, moisture, or by vermin, &c.
Cost, and current expenses.	

BRIDGE, PONTOON.—Blanshard's larger. Plates I. to V. VII. XV. XVI.

This Bridge is formed in rafts of two Pontoons each, and requires no sheer-line. The alternate rafts only are moored. When formed at 24 feet from centre to centre of each raft, this Bridge carries Infantry 4 deep (marching at ease), Cavalry 2 deep (horses led), and Light Field Guns. At 16 feet, Heavy Field Guns, or large Carriages. Siege Ordnance, &c., must be towed across on rafts of three cylinders each, should there not be Pontoons enough for close order, as given in fig. 1, Plate II.

The men for laying the Bridge fall in two deep; numbering off by 3s from the right throws them into crews of 6 for each raft, as Non-Commissioned Officer parties. The rafts number from front to rear; the odd numbers are the *Mooring Division;* the even numbers, the *Reserve Division.* The front rank of each crew is the larboard squad; the rear rank, the starboard. Nos. 1 Std. and 3 Ld. are anchor men.

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* The following Table gives nearly the relative heights remaining above water of the Square, the Circle, and Equil. Triangle, of equal areas on submersion to $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$ of their buoyancies; the two last figures giving (with reference to probable forms) the extremes of greatest and least area in relation to periphery.

	A Square.	B Circle.	C Equil. Triangle on its base.	D Equil. Triangle on its vertex.
Buoyancy reduced to $\frac{1}{2}$ . .	50	57	93	39
" $\frac{2}{3}$ . .	33	42	76	24
" $\frac{3}{4}$ . .	25	34	66	18

Hence, could stability be given to C, it would *in this respect* be the best; then B; then A; and D, the worst.

DETAILS OF ONE WAGGON LOAD.

Larger Bridge.—1 Raft.

Abbreviations used.	Stores. Description.	No.	Dimensions of each store. Length.	Breadth.	Depth.	Weight of one. cwt.	qr.	lbs.	Total weight. cwt.	qr.	lbs.
			ft. in.	ft. in.	ft. in.						
A	Anchor	1	3 10 Shank.	0 2 Fluke.	0 1 Fluke.	0	2	0	0	2	0
B	Baulks	12	14 2	0 3	0 4½	0	1	12	4	1	4
b	Buoy	1	1 6	0 9	0 9	0	0	3	0	0	3
bh	Boat-hook . . .	1	16 0	,,	,,	0	0	9	0	0	9
C	Chesses . . .	10	11 5¼	2 1	0 1½§	0	3	16	8	3	20
c	Do. half . . .	4	11 5¼	1 0½	0 1½§	0	1	23½	1	3	10
X	Cable	1	168 0*	,,	,,	0	3	14	0	3	14
F	Fender, body . .	3	2 0	0 4	Web.						
G	Girth, do. . . .	3	8 9	0 4	Web.	0	0	6⅔	0	0	20
BL	Lashings, do. .	3	12 0‡	,,	,,			oz.			oz.
CL	——— carriage	4	22 0‡	,,	,,	0	0	1 10½	0	0	6 10
RL	——— rack .	8	6 0†	,,	,,	Included in 'Rack sticks.'					
SL	——— saddle	4	15 0‡	,,	,,	0	0	1 4	,,	,,	5
bl	Line, buoy . .	1	60 0‡	,,	,,	,,	,,	5	,,	,,	5
Z	—— breast . .	1	60 0‡	,,	,,	,,	,,	5	,,	,,	5
O	Oars	7	14 0	,,	,,	0	0	15½	0	3	24½
P	Pontoons . . .	2	22 0	2 8	2 8	4	0	3½	8	0	7
R	Rack sticks . .	8	1 6	0 1¾	0 1¾	0	0	1¾	,,	,,	14
S	Saddles . . .	2	12 0	1 2	0 3	0	3	1¾	1	2	3½
sp	Side pieces . .	5	10 4	0 2¾	0 4½	0	1	1	1	1	5
			Total weight of stores						28	3	15⅝
K			Weight of carriage						13	2	24

Small, or Infantry Bridge.

Abbreviations used.	No.	Dimensions of each store. Length.	Breadth.	Depth.	Weight of one. cwt.	qr.	lbs.	Total weight. cwt.	qr.	lbs.
		ft. in.	ft. in.	ft. in.						
A	1	Small.			Anchor & cable.			0	2	0
B	30	6 6	0 3	0 1½	0	0	5	1	1	9
b	1	1 6	0 9	0 9	0	0	3	0	0	3
bh	1	16 0	,,	,,	0	0	9	0	0	9
C	20	8 0	1 4	0 0¾§	0	0	23½	4	,,	20
c										
X	1	120 0†	,,	,,	Included with anchors above.					
F										
G										
BL										
CL	2	30 0‡	,,	,,	0	0	2½	0	0	5
RL	10	6 0†	,,	,,	Included in 'Rack sticks.'					
SL	10	12 0‡	,,	,,	,,	,,	1	,,	,,	10
bl	1	40 0‡	,,	,,	,,	,,	3½	,,	,,	3½
Z	1	60 0‡	,,	,,	,,	,,	5	,,	,,	5
O	5	Paddles.	,,	,,	0	0	8	0	1	12
P	5	14 10	1 7	1 7	1	0	8	5	1	12
R	10	1 6	0 1¾	0 1¾	0	0	1¾	0	0	17½
S	5	8 4	0 9	0 3	0	0	19	0	3	12
sp	5	12 0	0 3	0 1½	0	0	11	0	1	27
								13	2	5
K								9	,,	,,

* 3½-inch rope, tarred. † 2-inch rope, not tarred. ‡ 1-inch rope, not tarred. § Planking only; the cleats have the same thickness as the planking.

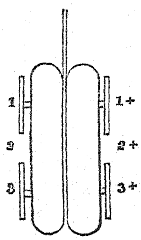
PONTOON EXERCISE.

Larger Pontoon Bridge.
1. Pack the carriage.
2. Unpack do.
3. Form Bridge from shore.
4. Dismantle do.
5. Form divisions and columns from Bridge.
6. Form Bridge from Rafts.
7. Land Stores and Pontoons from do.

Infantry Bridge.—1. Formation of Bridge. 2. Movement of Bridge.

1. *Pack the Carriage.*—Vide Plate I.

Prepare to Pack Carriage. The crews march along rear of K^s, (the right towards them,) and halt opposite them respectively.—Form upon your respective Carriages,—Right Face,—Quick March. They form up thus:



N. C. O.

The starboard squad are henceforth distinguished by the mark +

Collect the Stores for your respective Carriages. Each crew brings up 1 P, 1 S, 5 C, 2 *c*, 6 B on each side of K; 7 O and *b h* larboard; 5 *sp*, X, A and *b* starboard. The following to be put in box in front,—3 B L, 8 R, and 8 R L, Z, *b l*, 4 S L, 4 C L, 8 grummets and 4 pins. N. C. O. having seen all right, falls in as above.—Baulks. 1+, 3 at front and rear of K, receive B^s from 2+, 3+, 1, 2, packing them as shewn in fig. 4, Plate I.—Chesses. Do. do. do.—Saddles. Each squad brings up 1 S with cleats down, and pins outwards, within an inch of outer edges of C^s.—Lash down Saddles. 1, 1+ lash S to forebolster; 3, 3+ to hind bolster; 2, 2+ lash A, *b* to perch.—Side pieces and Cables. 1+, 3 receive these from 2+, 3+, who then hand up X, which is laid on sp^s by 1, 2, who pack.—Prepare to raise the Larboard Pontoon. 1, 1+ at head; 2, 2+ centre; 3, 3+ stern.—Lift. All lift together; put P on larboard S, pump-holes downwards.—Prepare to raise Starboard Pontoon,—Lift. Do. do. do.—Lash down Pontoons. 1, 1+, 2 lash head; 3, 3+, 2+ stern; the handles to S^s by belaying cleats. 1, 1+, 2, 2+ then pass up O^s and *bh* to 3, 3+, who divide and lash them to the inside handles.—Pass the Body-lashings over the Pontoons. 2 on top of P^s adjusts F^s; 1, 1+, 3, 3+ pass front and rear BL^s and 2+, centre BL over P^s; when F^s are adjusted 2 falls in.—Lash the Body-lashings. 1 and 1+, 3 and 3+ lash respective ends to bolsters; 2, 2+ cross their lashings through centre rings, and belay to triangular rings.

2. *Unpack the Carriage.*

Unlash and cast off Body-lashings. The whole unlash and cast off their respective BL; 3 and 3+ unlash O^s; 2 gets on P^s, and disengages F^s; 1, 2, 3 make up and put lashings into small box in front; then take out O^s and *bh*, lay them on ground, larboard side of K.—Unlash Pontoon Lashings. 1, 2, 1+ unlash head; 3, 2+, 3+ the stern.—Dismount Larboard Pontoon. 1, 1+ at head; 2, 2+ centre; 3, 3+ stern.—Lift,—Lower—Down. P placed gently on ground, larboard side of K.—Do. do. Starboard Pontoon. Do. do.—Unlash and Dismount Saddles. 1, 1+ the fore lashings; 3, 3+ after lashings; placing each S by its P. 2, 2+ unlash A and *b*.—Dismount the Stores. 1+ at head; 3 at rear of K, who pass as follows, X and 5 *sp* to starboard; 5 C, 2 *c*, 6 B to both squads, on each side.

3. *Forming the Bridge from Shore.*

Roll P^s gently into water below point where Bridge is to be; bring them up into place against stream. A Bridge over a wide river may be formed in several parts of 7 or 8 rafts simultaneously, which are to be warped into Bridge on alignments ashore.

DUTIES OF EACH RAFT.

Raft No. 1. 1, 1+ Cable Men who keep Bridge in proper position; belay X^s to rafts by the S belaying cleats opposite A^s; shifting them as Bridge is boomed out.—2, 2+ Side Piece Men who lay and lash the sp^s ready to be racked down by the whole of the crews when Bridge is completed; ends of sp^s not to overlap immediately above S^s.—3, 3+ lay C^s; see that joint of the 2 c^s is over centre of S^s, and flush with belaying cleats. It is the duty of the N. C. O.s of the Mooring Division to see that they have the A^s from the carriages of the Reserve Division.—Raft No. 2. 3, 3+ haul P^s in readiness to 2, 2+, who pass P^s under S^s, ready for 1, 1+, who lash them by 3 turns over S^s, and twice in front close to end of S, making fast by 2 half-hitches.—Raft No. 3. Front Saddle Men. 1, 1+, 2, 2+ pass and pack C^s on last inserted P; 3, 3+ pin B^s to 2d S from land, assisted by Baulk Men.—Raft No. 4. Baulk Men. 1, 2, 3, 3+, 2+, 1+ bring up B^s respectively, helping to pin B^s to S^s. In the 1st raft B^s are shipped between the outer cleats.—Rafts Nos. 5, 6. Chess Men, who pile the C^s and c^s on and across the B^s joining the shore-bay. In No. 5 Raft, 1, 1+ the 2 c^s; 2, 2+ the 1st C; 3, 3+ the 2nd; in No. 6 Raft, 1, 1+ the 3rd; 2, 2+ the 4th; 3, 3+ the 5th, successively; the wide space between the cleats towards river.—Raft No. 7. 1, 1+, 2, 2+ Saddle Men; 1, 1+ bring up front S, lay it parallel to river, pins towards land; 2, 2+ place 2d S about 12 feet in rear of and parallel to 1st S; pins towards river, and so on alternately; they help to pin B^s to rear S. —3, 3+ Side Piece Men: they place 2 sp^s on the tier of C^s or 2d inserted P; 3 on next; and so on alternately as the C^s are packed.

Prepare to Boom-out. Only 3 bays are worked at once in this.—No. 3 Raft, man front S; No. 4 the 2d; No. 7 the 3d. In these crews 1, 1+, 2, 2+ of each man, the ends of their respective S^s; 3, 3+ get between the B^s.—Vide Plate IV. fig. 1.

Rack Down. Each man takes 1 R, 1 RL; each N. C. O. 2 of each; 1, 1+, 3, 3+ rack down over the P^s; 2, 2+ over centres of rafts; N. C. O. over centres of bays. Two small boats and crews (or 2 Blanshard's Infantry Bridge Rafts) are necessary for each portion of the Bridge; one for casting the upper A^s, the other for the lower A^s, and returning the end of X to the Cable Men. In strong currents, 4 or 6 additional men should be on the Bridge to man X^s. When the B^s are laid at close order, Bridge is strengthened by 2 sp^s, as shewn in Plate II. fig. 1.

4. *Dismantling Bridge ashore.*

In dismantling Bridge each undoes what he has already done. The inshore C^s go first to rear; Bridge is then drawn ashore by the B^s till 1st P comes to the bank, when its S is unlashed, P is withdrawn by its proper men, and so on. 3 S^s (with their B^s still pinned) must always be ashore before they are successively unpinned.

5. *Formation of Divisions, and Columns from Bridge.*

Attention—Prepare to Dismantle, and Form Divisions against Current,—Dismantle. Each man removes 1 R and 1 RL, hands them to 1, 1+, 3, 3+, to reeve them through P handles, with ends and sticks across P: 1, 1+, 3, 3+ then turn over the 2 c^s, placing them flush with the outside C^s of raft: whilst 2, 2+ lay the 5 sp^s on the 2 c^s furthest from shore; they also remove the C^s and stow them as before; also take up the 4 centre B^s on C^s. (Vide Plate III.)—Unpin. 1, 1+, 3, 3+ unpin outer B^s and place them with the rest; the lower B should be unshipped first.—2, 2+ lash the sp^s and lay O^s and *bh* ready for rowing. The Anchor Men bend X^s together ready to weigh: Z^s are not cast off till word is given. Rafts of Reserve Division drop down till they pass the line of A^s, get quickly out of the way and keep there, heads to stream. When the Commanding Officer of Mooring Division sees this done, he gives the word—Prepare to Weigh Lower Anchor. Each raft having repeated the word, weighs independently. 1, 1+ warp on lower X, 3, 3+ veering out gently. 2, 2+ man the O^s as the N. C. O. aft directs. When raft is hauled home to A, 1, 1+ weigh it; 1+ begins to coil X, and 1 hauls in *b* and *bl* and coils it. When the bend of the 2 X^s comes on board, a new coil must be begun without unbending it: 1, 1+ then capsize 1st X, placing A, *b*, and *bl* upon it.—2, 2+ now facing upper A will work up to it; when reached, 1, 1+ man their oars; N. C. O. ships his for steering and awaits orders; all rafts to act simultaneously on the word—Weigh and Reverse to the Right (or Left). Pull Round Larboard (or Starboard). Back-water Starboard

(or Larboard). When all are thus reversed,—Give Way of All. Whilst 1, 1+, 2, 2+ sheer their rafts, 3, 3+ weigh A; 3+ gets *b*, *bl* on board, placing them and A on X: 3, 3+ take their oars.

Mem. In case of tide turning, in tide-rivers, the original positions of A^s,—of the Reserve Division,—as well as the duties of 1, 1+, 3, 3+—of the Mooring Division, become reversed.

When Bridge is about to be made, rafts must always be in divisions, the mooring division above.—(Vide fig. 2, Plate II.) In rowing with current, which is the regular rule of forming Bridge, reserve division leads; but in reverse order, or against stream, mooring division leads.—When in divisions, the ends of the oars should have a clear space of about 12 feet from the next.—When in column, the leading rafts should be far enough apart to allow the intermediate rafts of that division to form up in line: thus, with thirteen rafts, Nos. 3 and 5 have to come up between Nos. 1 and 7. Succeeding rafts in column to be 2 P length apart. With an odd number of rafts, the extra raft is on same side as No. 1.

Examples of Columns.

7 Rafts.		13 Rafts.		14 Rafts.	
1	5	1	7	1	9
3	7	3	9	3	11
2	6	5	11	5	13
4		2	13	7	8
		4	10	2	10
		6	12	4	12
		8		6	14

6. *Formation of Bridge from Rafts.*

Prepare to form Bridge from Rafts. Baulks to be handed to the present Right (or Left.) This is as caution only. 'Present' is used, because the Reserve Division has to reverse before the stores are handed.—Prepare to cast Stern Anchor. Each raft repeats this; 3, 3+ lay in O^s; 3 holds A ready for heaving; 3+ clears, and holds ready *b* and *bl*.—Heave. 3 heaves A; 3+, *b* and *bl*, into water, and veer out X cautiously; the rest continue rowing. The N. C. O. of each raft gives the 3 following words independently.—*Prepare to cast Head Anchor.* 1, 1+ lay in O^s; 1+ holds A ready; 1 clears, and holds *b* and *bl* ready: 2, 2+ continue rowing; each N. C. O. must be ready to heave when about ½ his 2d X is veered out.—*Hold on.* 3, 3+ cease veering, and hold on: 2, 2+ rest on their O^s.—*Heave.* 1+ heaves A; 1, *b* and *bl*: 3, 3+ then bring raft into place, warping on stream A; 1, 1+ veering out cautiously.—3 and 1+ are now called Anchor Men, and have exclusively to mind A^s until raft is moored.—1, 2, 2+, 3+ are called Baulk Men, and have to unlash sp^s; pass and pin B^s, commencing with stream B, then lower B, then 4 centre B^s.—2, 2+ steady the raft whilst warping into line. When the bend is on board, 2, 2+ lay in O^s; 3, 1+ unbend, and hold on by X^s

for slight adjustments, and till ordered to belay, as soon as Commanding Officer has dressed the line.—Whilst raft is mooring, Baulk Men unship, and lay *sp*s on Cs, on side farthest from shore; also lay *bh* and Os over head and stern,—larboard Os head; starboard Os stern.

RESERVE DIVISION.

Whilst mooring is going on, Commander of Reserve Division will reverse his Division to right (or left), and wait opposite proper intervals, till ordered into line: as they approach, N. C. O. gives the word In Bow, when 1, 1+ lay in Os, and catch Zs from Mooring Division, by which they work up, take post, and make fast to P handles.—N. C. O. gives word In Oars; Os are at first laid beyond Bs, on side of 2d tier of Cs.—1, 1+, 3, 3+ immediately unlash *sp*s, put them on Cs farthest from shore, laying Os and *bh* over head and stern, and lose no time in connecting with neighbouring rafts; 2, 2+, 3, 3+ pass and pin outer Bs. Should the intervals of the Mooring Division be too great, or too little, the whole must be adjusted by *bh*, Z, or Bs, of which last, the ends of the outer ones in Reserve Division should always be pinned first, so as to give a ready hold for management. As soon as 2 outer Bs are fixed, no time should be lost in pinning the rest. —The 2 *c*s to be laid over Ps by 1, 1+, 3, 3+ on each side of raft; the Cs are laid on in one direction, that is, over proper bay of raft; Nos. 1 and 3 of that side of raft only being employed in laying, and the rest in handing Cs.—In preparing for Racking-down, *sp*s are laid on edge, and overlap 10 or 12 inches; both ends, inside and outside alternately: they are lashed by the grummet lashings.— 1, 1+, 3, 3+ hand *sp*s to 2, 2+, who place them only, and then receive 2 RL from the same, and rack down on centre of bay; the N. C. O. receives 2 RL, and racks down at centre of raft; 1, 1+, 3, 3+ do the rest.—R is to be turned down alongside of *sp*, outside.—*bh* and Os as before, though on Service they would go ashore till wanted.—When Bridge is formed, men sit down, facing outwards over the edge of Bridge; 2, 2+ at centre of raft, and the rest over Ps.

For the Bugle Sounds, see Plate XV.—For the necessary Knots, &c., see Plate VII.

7. *Landing Stores and Pontoons from Rafts.*

To be occasionally practised. Rafts to be hauled alongside of bank; 2 *c*s to be used as gang-boards; the stores to be landed and piled in good order, near own raft. 1, 1+, 3, 3+ will unlash Ss, so as to be able to roll the Ps up; Ps always to be placed on Cs, or *c*s, to prevent injury.

MEMORANDA.

No boats to approach on stream side. Heavy boats not to make fast to Bridge. Pay attention to the coiling of X, and see that A is properly placed and clear. To practice the men in sheering, (taking care not to rasp X on the edge of the raft in so doing,) and heaving A.—Never to let them come with the stream upon an object, but reverse first, and come to it against current.—To perform every operation with neatness, and bring and pile all stores carefully ashore. No man to lift a C singly,

and not less than 6 men to a P. If wet work is necessary, to keep a party expressly for that.

Usual Times of Operations at Chatham.—To boom out 8 rafts, completing 200 feet of Bridge, 15 minutes.—To warp and place 2 pieces of the same length in same alignment, 20 minutes. 600 feet of Bridge complete, 35 minutes.—To dismantle same Bridge and break into rafts, 8 or 10 minutes.—To form the same again from rafts, from 15 to 20 minutes.—To break up Bridge in 3 portions; to land it by same rule as boomed out by; and pack on K^s ready to march, 1 hour; that is, if the banks are favourable for bringing up K^s.—To dismount the different parts of a raft from K, and unpack, 4 or 5 minutes.

BRIDGE, PONTOON.—Blanshard's Small, or Infantry. (Plates VI. VII. XVII. XVIII.) Pontoons 5′ 4″ apart from centre to centre; will pass Infantry 3 deep; and with care, Light Field Guns, or Carriages.

Distribution. Fall in 2 deep. Tell off by 2^s (or 4 men per P.) Number each party. Nos. 1 are outer files (or right side of Bridge). Nos. 2 are inner files (or left side of Bridge).—Form Bridge on Centre* (or named) Pontoon. Nos. 1 take up P^s, and range them from named P.—Nos. 2 each take 3 B^s, and fall in by their respective Nos. 1.—Nos. 2 of named and next P^s hand the ends of half the B^s to Nos. 1 to pin, whilst they do theirs. When all is laid, Nos. 2 go for C^s; the 1st C is laid over S of named P. The horns of C ledges all to be laid towards Bridge head. When Bridge is on water, the *sp*^{s} or the O^s are lashed to C^s over S^s. To carry the Bridge, a R is passed through the ring at each end of P, and the 2 men at each end lift it.—Prepare to raise the Bridge,—Raise,—Quick March,—Right (or left) oblique,—Right (or left) turn,—Halt. The eyes of S^s must be towards Bridge head, except those of the head S. The B^s to be lashed to S^s prevent turning over.—When Bridge is formed into rafts, the 2 outer B^s are secured to the eyes on S^s put for that purpose. P^s should be slidden into water over *sp*^{s}.—To move Bridge down a scarp, or steep bank, omit C^s over S^s, or turn them back on next C^s, and then together with the 3 C^s over bays they must be lashed by CL^s; the lashing of each (forming a noose round B, in front,) is tied to pin lashing on after-S, or else the ends of B^s would rise over C^s, and not sit level.—(Vide Plate VI. figs. 1, 3.) Guys (X^s) are to be used to steady the Bridge on booming out, each to be held by 2 men, one on the Bridge, the other ashore, to each guy.

Rafts can be used as boats, to take out A^s, &c., &c.: they can be sculled by 1 man, the paddle resting on the after-bolster of a K racked down: or they may be rowed by 1 paddle on each side, supported by 3 B^s secured by CL or RL: or a raft may be paddled by 4 or 6 B^s. Thus a Bridge may be broken up and sculled, or rowed, or paddled off. The B^s and C^s of the bay may be taken on board each

* The Bridge, when formed on centre, proceeds at double the rate of formation, as the parties work both ways at once towards the ends.

raft, and the Bridge re-formed any where. In dismantling, it is easier to do so from rafts, than by hauling Bridge ashore. When Bridge is to be much used, the *sp*s must be lashed down over Cs, their ends meeting over centres of bays; or the Os must be lashed down, their blades overlapping in like manner.

This Bridge affords means of surprising an enemy, especially in a country much intersected by water. It may be taken, when in pieces, through narrow paths, the Ps being carried lengthwise by a man at each end; and may be put together in the night, and immediately passed over an unguarded point of a river. It may be brought forward concealed by a close column of Infantry, which would be ready to pass immediately. In case of a double river, the 2d length of Bridge required may be passed over the 1st, a C being lifted in the centre of each bay, which would allow of the men getting between the Bs and carrying it on their shoulders. It may be passed down a steep bank, or counterscarp, on ladders, taking care to omit the SC, and lashing the 3 other Cs to the Bs.—Vide fig. 3.

The following has been done with 12 Ps. The whole length of Bridge was put together in about four minutes, and moved about in various directions in Quick-time; then down a shelving bank without delay; and lastly down an 8-feet wall, when it was fit for passing troops. Fifty men were afterwards crowded on about 20 feet of the Bridge, and marched on it three deep. A 6-pounder and limber being placed on it sank the Ps a little more than half. It has been passed down about 30 feet of ladder over a counterscarp, and stood the shock of one of them (decayed) breaking, without injury. A horse was taken across it, turned, and brought back satisfactorily.

The actual expense, &c., of making 1 Infantry Pontoon at Dublin, in 1844, was,—92 sheets DXXX* tin, 53*s*. 8*d*.; 13 lbs. tinman's solder, 6*s*. 6*d*.; 2 bushels charcoal, 2*s*. 6*d*.; 2 lbs. rosin, 3*d*.; 2 iron rings and staple-bolts for ends, 1*s*. 6*d*.; 15½ days of 1 tinman (Sapper), 15*s*. 6*d*.; 3 lbs. paint, 1*s*. 6*d*.; ½ day of 1 painter (Sapper), 6*d*. Total, £4. 1*s*. 11*d*.

BRIDGE, BOAT.†—Plate VIII.

Small craft should be collected from up and down the stream, as well as from tributaries to the river; and when a Bridge of this sort is contemplated in the presence of an enemy, a rapid and well-disguised movement should be made to collect the Boats.

Such vessels as are built for cargo are best adapted to this purpose,—neglecting the slighter kinds of boats used for passengers only, except the few that may be necessary during the construction of the Bridge.

As soon as they are assorted to each side of the river, the inequalities of size, and the irregularities that would be thereby produced in the Bridge-floor, must be made good by trestles (figs. 1, 2, Plate VIII.) along the centres of the Boats: the baulks must lie on these trestles, and never on the gunwales of the Boats, which would certainly be crippled.

Allowance must be made for the degree of pitching and rolling to which the Boats may be subject,—in the distances between them,—and in the manner and extent to

* This was supplied in Canada for the repairs of the Pontoon Train; but DXX is nearer the mark, so as to give the weights recorded, though not so good a material.

† Abridged and modified from Sir H. Douglas.

which the baulks are to overlap one another at the ends. On the Adour Bridge, this motion was occasionally so great as to render it then fit only for Infantry. Whether the Boats are to be anchored stem and stern throughout, or partially so, will depend on liability to turn of tide, backwater, floods, &c.

Bridges should, in general, be on straight lines across the river; the idea of their receiving strength from an arched form is fallacious, as no general lateral abutment takes place; each part being mainly dependent on its own moorings: in tide-rivers, likewise, this arrangement would be reversed every tide.

The sizes of the Boats cannot well be specified; the most suitable must be taken that can be had; but, generally, they should be such that when the Bridge is completed, and under its extreme burthen, the Boats' gunwales should be at least 1 foot above the water.

Mem^{m}.—The Bridge over the Indus, by Capt. G. Thomson, H. E. I. C. Engineers, is recommended as an *excellent* study in Boat Bridges.—Vide Corps Papers, vol. iv. p. 92.

BRIDGE, ROPE.—Plate IX.

Rope Bridges, of a complicated description, will not be given, being unfit for military purposes; and especially objectionable on the grounds of economy, and liability to destruction.*

Those that are suited to temporary and military purposes are extremely simple: that made by Colonel Sturgeon, over the broken arch at Alcantara, in 1810, is given, chiefly from a drawing by the Staff Corps. This Rope Bridge spanned 100 feet; it was removed and replaced with ease; and was readily packed for transport. It was adopted from the impossibility of procuring proper timber to restore the communication.

Colonel Sturgeon's Bridge is constructed thus:—Three hawsers, A, are strained between 2 beams, B; over this, by means of the blocks and tacles, C, is drawn the net-work, D (stretched between the 2 beams, E), which supports the cross-beams, F, bearing the joists, G, and the planking, H. The whole is steadied by the guys, I.† The net-work outside the planking is covered by a stripe of tarpaulin, J, to prevent horses, &c., from being frightened; and a light side fence of rope, K, supplies the place of a hand-rail.

A and B are hauled taut by capstans to the 5 tacles, C, at each end. B and C lie in grooves cut in the road-way: B also passes through the parapet wall on both sides, if for the restoration of a Bridge; or is abutted behind piles, or trees growing on the banks, if for an independent Bridge. D and E are strained in like manner. D consists of one rope, passed 19 turns round E, within the breadth of 18 feet; the 10-feet lengths for F are marked off, and well tarred at the places where F are to lie: these 10-feet lengths are subdivided into 3 parts to mark the meshes, which are gathered in, and seized with spun-yarn. F are notched at 1-foot intervals, so as to fit down on

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* As an extreme case, however, a sketch of a Field Suspension Bridge, somewhat on Dredge's principle, is given, fig. 9, Plate XIV. The strong cables that are necessary where all the weight rests on two or three main ropes, are not always to be had: in the present instance, where the burthen is divided among many suspenders, far smaller and more generally obtainable materials will suffice. In the sketch, the point A is obtained by a sufficient number of jumpers sent into the face of the rock; the ends of the ropes being secured in like manner above, if no trees, &c., &c., are to be had. Should no such local resources for fixing A and B present themselves, strong trestles must be substituted. This sort of Bridge must be well steadied by guys.

† Cannot be shewn in the Plate: they led from the centre of the Bridge, on both sides, to the banks above and below.

the net-work, to which they are lashed by a running lashing of Hambro' line. G in 10 rows; these are rounded off, and strapped with iron at the ends; the holes *a*, *a*, *a*, fig. 3, admit of adjustment in the wood-work, when any change of length takes place in the rope-work, from contraction by wet; or extension from the weight supported. The planking, H, is looped together by spun-yarn at *b*, *b*, fig. 1.

Table of Materials and Transport necessary for a Bridge as above described.

Reference to Plate.	Stores.	No.	Dimensions. Length.	Breadth.	Depth.	Weight. Detail.	Gross.	Loads of a 4-wheeled Waggon.
	TIMBER.		ft. in.	ft. in.	ft. in.	lbs. (At 40 lbs. per cubic foot.)	cwt.	
B	End-ties	6*	15 0	1 0	1 0	3600		2
E	Main beams	2	22 0	1 0	1 0	1760		1
F	Cross ditto	11	20 0	0 6	0 8	2960		2
G	Joists, single . . .	50	11 4	0 2	0 6	1920		1
G	Ditto, double . . .	100	11 4	0 1½	0 6	2840		2
H	Planking, 9 inches wide	187	12 0	0 9	0 1½	8440		6
			Total timber . .			21520	193	
	ROPE-WORK, &c.					(Calculated on weights as given in 'Cable.')		
A	Hawsers	3	170 0	9-inch.		1581		1
C	Tacles	10	96 0	4½-inch.		749		1
C	Lashings to blocks, &c.	40	30 0	4½-inch.		936		
D	Net-work	1	2000 0	3-inch.		700		1
I	Guys	4	200 0	3-inch.		280		
K	Side fences	2	400 0	1½-inch.		72		
	Lashings to F . . .	11	50 0	Hambro' line.		50		
J	Tarpaulins	2	100 0	3 0	,,	448		1
	Spun-yarn	4	cwt.	,,	,,	448		
	Treble blocks . . .	20	1 3	,,	,,	800		
	Double ditto . . .	8	0 9	,,	,,	62		
			Total rope, &c. .			6126	55	
			Total weight of bridge .			27646	248	18

BRIDGE, BOAT AND ROPE.—Plate VIII.

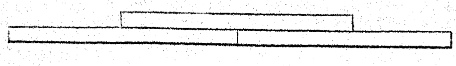
The Bridge over the Adour, designed by Colonel Sturgeon, of the Staff Corps, and executed by the Royal Engineers, is the finest example on record of this kind of communication.

The arrangement of the tension gear is much the same as that used at Alcantara.

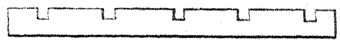
The Plate and Description are from Sir H. Douglas, and Sir J. T. Jones, R.E.

"Forty-eight chasse-marées were taken up in the ports of St. Jean de Luz, Socoa, and Passages; collected at Socoa, and each loaded with

* In mountainous countries, it will rarely be practicable to carry beams long enough to go through both parapet walls of such a Bridge; nor is it always easy to obtain them. Three pieces have therefore been allowed for each end-tie, to be made into one beam thus,—by lashing them together: provision is made in C, above, for these lashings.



48 3-inch planks, 9″ × 12″.

1 Sleeper, 10″ × 10″, notched thus : 

2 Hand saws.

2 Axes.

2 Skeins Hambro' line, to lash the planks to the outside cables. Two men of the Corps of Royal Sappers and Miners were put on board each vessel to level the waist-boards with the decks, so that the cables might be stretched across as soon as the vessels should be moored. The floor was supported by five cables, lashed in the notches of a sleeper placed fore and aft, on the deck of each vessel. Five cables, 13 inches in circumference each, and 120 fathoms long, were put on board the chasse-marées destined for the centre of the Bridge, and so coiled that they could be handed up the hatchways, right and left, at the same time.

" The river was bounded on both sides by perpendicular stone walls, 14 feet high, and the same thickness. That on the left bank was backed behind by sand, level to its surface; while the ground behind the wall on the right bank was 12 feet lower than the top of the masonry, and covered at high tide by 7 feet water. The rise of the tide, at Springs, was 14 feet.

" On the right bank, the end of each cable was fastened to an iron 18-pounder, which was thrown over the wall. Those parts of the cables which rested on the masonry were served with green bullock hides, to prevent rubbing. On the left bank, they were stretched by capstans and gyn tacles, fixed to a frame of timber laid on the sand behind the wall, 3 feet lower than the top of the masonry, (Bridge, Plate VIII. figs. 5, 6,) and loaded, in the rear, with sand-bags, to prevent it from tilting upwards.

" The chief disadvantage in substituting cables for beams is, that the navigation of the river cannot be opened by removing one or two Boats, with their proportion of floor; for the cables being stretched by capstans from bank to bank, and only borne by the Boats, cannot be secured but by spanning the whole river. Cables are, moreover, expensive, and with every precaution very soon chafe. Hence the application, excellent as a temporary expedient, should be replaced by beams as soon as they can be procured; when care must be taken to apply them so as to allow for the undulating motion of the Bridge in gales of wind."

Memorandum.*—In the first instance, the Boats had each one anchor ahead, and another astern, so as to meet the turn of tide; but, from the violence of the current, it was soon found that not less than 2 anchors at each end were necessary. In this case, great care is necessary to avoid fouling the anchors, and it will be best done by their being cast, as it were, 2 deep, by the alternate Boats throwing them out as far from, and the others as near to, the Bridge, as can be done with safety and convenience.

* By a R. E. Officer who saw the Bridge.

BRIDGE, CASK.—Plate XI.

When no Pontoons or Boats can be had, Casks, formed into Piers, offer a good substitute; they were thus used by Lieut.-Colonel Goldfinch, R.E., over the Nive, in January, 1814.

The Chatham practice is given, as arranged by Major-General Pasley, based on the above and other experience; leaving modifications to the circumstances of the service under which they are required.

General Pasley's Bridge consists of rafts managed much on the same principle as the modern Pontoon Equipments; each raft composed of the ordinary superstructure laid on two piers of seven casks each,—put together as shewn in figs. 1, 2, 3, Plate XI.

The stores for such a raft will be—

14 Casks, or water-butts, 4′ 3″ long × $\left\{\begin{matrix} 2'\ 9'' \\ 2'\ 2'' \end{matrix}\right\}$ averaging 174 lbs. in weight.

A 4 Side pieces, each 21′ × 4″ × 5″.
B 4 Slings, each 36′ of $2\frac{1}{2}''$ rope.
C 24 Braces, each 18′ of $1\frac{1}{2}''$ rope.
D 2 Transoms,
10 Baulks, (5 for Raft, 5 for Bridge,) $\Bigg\}$ each* 22′ 8″ × 4″ × $4\frac{1}{2}''$.
2 Spare baulks,
2 Anchors, cables, buoys, and lines.
2 Boat-hooks; besides oars, rack-lashings, &c.
Plank, or fascines, for the floor.

When a Bridge is to remain in the water for any length of time, chain may be substituted for rope in the parts immersed; or, as was done on the Nive, the Casks may be enclosed in an open frame of wood-work.

At open order, each raft will give about 37 feet of Bridge about 18 feet wide, and will bear Infantry, Cavalry, and a light 6-pounder.

At common order, each raft will give about 31 feet of Bridge, and will support a medium 12-pounder limbered up, complete with ammunition.

When Heavy Artillery is to be passed, it must be towed on rafts consisting of three or four piers instead of two; the floor proportionally strong; thus the weightiest ordnance may be taken across, the platform being about 30 feet long × 18 feet wide.

To insure stability, the piers should never be less than 20 feet long in any case.

Cask rafts can be rowed with tolerable facility in still water, or in moderate currents, but not against a strong one, or a high wind. In rapid rivers they are apt to have the stream end borne down; which must be remedied by giving a stream anchor and cable to each pier, secured, not immediately to the pier itself, but to a cask close in front, which is interposed as a breakwater, and which is attached to the end of the pier. Or the force of the water may be reduced by a projecting triangular breakwater of $1\frac{1}{2}$-inch plank, instead of the detached cask.

It is desirable to have the anchors and cables laid as moorings before the rafts are brought off to their stations, which are marked by the two contiguous buoys supporting the ends of the cables. If only a small boat, or Blanshard's Infantry Raft, can be had, it should be used in taking out the anchors; if not, a Cask raft must be used, taking care to work and drop *down* the stream as much as possible.

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* If these cannot be obtained in one length, they must be made by lashing two shorter pieces together.

The following Table is arranged in reference to Commissariat and Admiralty Casks, being those that may often be available; or will serve, approximately, for others.

Cask, &c.	Content.	Weight when empty.	External Dimensions. Head Diam.		Bilge Diam.		Length.		Extreme Buoyancy in Fresh Water.	Time * of putting together. Men.	Hours.	Remarks.
	Imp. gals.	lbs.	ft.	in.	ft.	in.	ft.	in.	lbs.			
Leaguer . .	164	230	2	6	3	$1\frac{3}{4}$	4	$10\frac{1}{2}$	1746	2	4	Used for water before the introduction of iron tanks.
Butt . . .	110	168	2	2	2	9	4	$4\frac{1}{4}$	1173	2	3	
Puncheon . .	72	135	2	1	2	4	3	5	694	2	3	Chiefly used for rum.
Hogshead . .	54	109	1	11	2	4	3	0	576	1	3	
Barrel . . .	34	71	1	9	2	1	2	7	407	1	2	
Half-hogshead	26	59	1	7	1	$10\frac{1}{2}$	2	4	292	1	2	
Kilderkin . .	18	45	1	5	1	8	2	0	194	1	2	
Tierce . . .	37	58	1	9	2	1	2	$7\frac{1}{2}$	428	1	3	Beef and pork.
Irish barrel .	25	47	1	6	1	$8\frac{1}{2}$	2	4	275	1	2	

For Commissariat purposes, and details affecting Store-room, see an extension of this in 'Tables of Departmental Packages.'

Hutton's Rule for Contents of Casks, modified for Imperial gallons, becomes—

$$(39\,D^2+25\,d^2+26\,D\,d)\times L\left\{\begin{array}{ll}\times\cdot0003143 & =\text{content in lbs. water,}\\ \times\cdot00003143 & =\text{content in gallons,}\\ \times\cdot000005043 & =\text{content in cubic feet,}\end{array}\right.$$

where D and d = bilge, and head diameters; L = length; all in inches.

BRIDGE, TRESTLE.—Plate XI.

These are chiefly applicable to rivers in hilly countries, where the stream—liable to sudden swellings—is generally too deep to be forded; and when a Pontoon, Boat, or Cask Bridge is not applicable, cannot be obtained, or cannot be forwarded.

The Trestles can be made of rough materials on the spot; or may be framed in the rear, passed on in pieces on mules, and quickly put together on the bank.

To give stability when sudden risings may be expected, or when the current is strong, heavy stones may be piled up inside; strong sheer lines, or even cables, may be passed across, to which the heads are to be lashed as the Trestles are laid, successively; large killicks may also be thrown out.—Vide fig. 6, Plate XI.

The figure given is nearly that of a Bridge by Lieutenant Wright, R. E., attached to Sir Rowland Hill's Division, in 1812. If of yellow pine, such a Trestle will weigh about $9\frac{1}{2}$ cwt.; and the superstructure per bay of 15 feet, including cables, will be about 16 cwt. in addition. In the above instance, fascines were used where planking could not be obtained.

* The workmen are supposed to be good; and the materials only to require putting together.

According to Sir Howard Douglas, Colonel Sturgeon, of the Staff Corps, threw a Bridge over the Agueda, at the ford of Marialva, near Ciudad Rodrigo, 396 feet long, on 18 Trestles, which were well loaded with stones, secured by coarse wattling, which allowed the water to pass through.

In the construction, care should be taken not to weaken the timber by mortises and tenons, or by halving. If the pieces are to be carried, and used a second time, it would be desirable, if iron and a small forge can be obtained, to make a certain number of bolts and screws for fixing the work together.

BRIDGE, RAFT.—Plate XII.

The last expedient that should be adopted by an army in motion;—to such, it is an indifferent substitute for Boats, Pontoons, or Casks, either when employed as a Flying Bridge (Trail, or Pivot), or as a Fixed Bridge.

It has the lowest degree of buoyancy,* and general manageability, and is inapplicable when the passage of a river is likely to be contested with animation.

Its merits are, that, at the expense of time, it can be constructed with less experienced workmen: it saves carriage, as it can be only made of materials on or near the spot,—cables, and a few such stores, being all that is indispensable from the rear: it is not liable to be sunk; and, if allowed to remain undisturbed, will last a long time with moderate repair.

Plate XII. gives the general form and construction. The Rafts should not be less than 45 feet long; they are best bound together by withes, or ropes, and stiffened with cross and diagonal braces. They are most readily built on the water; but, if they must be made ashore, they should be put together across two parallel baulks, or trimmed trunks of trees, sloping towards and close to the river, so as to be easily launched. With numerous and experienced workmen, such a Raft *may* be made in 5 or 6 hours. An independent Raft will require (at an average) two rows of trees at least to float as many men as can stand upon it, unless the trees are very large,—when they cease to be manageable, and are scarcely applicable.

Whether they are to be anchored in connection with a sheer line or not, depends on circumstances; the anchor, in such cases, may well be the fisherman's wooden killick (vide Plate XI. fig. 6), unless the Bridge is to last for any time, or is liable to unusually violent currents. Such were, however, used in the Passage of the Indus, in 1839; and, by a sufficient increase to their number and weight (even to $\frac{1}{2}$ ton), very powerful streams over rocky bottoms may be mastered.—Vide Corps Papers, vol. iv. Paper VI.

The figure is nearly as given in Laisné's Aide-Mémoire.

BRIDGE, PILE AND SPAR.—Plates X. XI.

Piles are used merely to obtain supports, either as piers or abutments; they are especially applicable when deep and wide rivers are to be crossed; but the nature of the bed must be considered, before any operation can be attempted.

Pile-engines form part of the French Engineer Field Equipment: for this, in its most complete form, vide 'Aide-Mémoire,' vol. ii.; the rough approximate expedients for supplying its place, either as a ram, or as a tilt-hammer, are too obvious to require a description.

* And if down for any length of time, becomes water-logged.

Spars, baulks, &c., can be applied as superstructure, to either a piled, or any other pier or abutment; whether to form, or to restore, a communication. The series of such Bridges as may be used in field operations gives much of the earlier history of framing and trussing, in reference to roofs as well as bridges. Of these,—the 1st would be merely spanning the opening, with timber sufficiently long, and covered with cross planks; or, in default of these, with fascines.

The 2nd, and next rudest form of arch (particularly observable in Egyptian architecture), is very strong, easy of construction, and of frequent occurrence in Nova Scotia (see Plate X. figs. 1, 2); the timbers being notched roughly into one another, as is done in building log-houses. A few of the upper courses may be trenailed down.

The 3rd step is given in figs. 3, 4.

The 4th in figs. 5, 6. In the construction of this, the first thing is to form a horse, or trestle, on which the remainder of the work is to lie until secured: to effect this, cut a step, *a*, low down, and well in rear of, the arch, so as to admit of a strong party standing there to pull over, and hold up with ropes and by main force, the 2 pair of spars, *b*, *b*, *b′ b′* and the cross piece, *c*, previously lashed together, and fitted with 4 guys at each end; thus firmly held up, 2 light and active men climb up, and lash *e*, *e*, *d*, *d*: a general framing being thus made, the rest may be added in the following order:—the remaining rafters, *g*,—the cross pieces, *c′*, *j*, *j*,—the remaining collars, *d*,—the cross pieces, *f*, *f*,—the frames, *h* (like ladders on their sides), going entirely across as intermediate supports; and finally, the joists and planking, or fascines. Diagonal braces, *i*, *i*, *i*, must be used, to give general lateral stability during the process and at its completion.

The 5th, figs. 7, 8, applicable when 2 spars will not reach across: it may be executed in much the same way; paying great attention to fix diagonal braces as soon as possible, even if but temporarily.

Both of these can be more readily thrown across an open stream (where there is plenty of room to extend the guys, and put on main force in the first instance,) than, as above, in the repair of a bridge.

Figs. 9, 10, Plate X.; figs. 11, 12, 13, Plate XI., are common in Canada.* In a roof, the weight is thrown on the rafters, and the cohesive strain on the tie-beam and king-post. In these Bridges, the tie-beam bears the transverse strain, whilst the tendency is no longer to snap, but to crush, the rafters; as well as to pull up the king-post, or force its head off. In fig. 11, the rafters, *a*, *a*, of fig. 9, Plate X., are represented by the shores, *b*, *b*.

The above, as elements, can be occasionally combined,—*e. g.*—fig. 3 with figs. 9 and 12; or they may be repeated as separate and successive arches, as well as extended in width, so as to be doubled or trebled laterally, as in fig. 13, &c., &c.

The minor details of construction, in the above, are left to the general experience of the Officer; but he cannot, in figs. 9 to 13, too carefully avoid crippling the main pieces, by halving, or by using mortises and tenons, dovetails, &c.; all of these, not only enfeebling the whole, but (the mortise and tenon) rendering it difficult to take down a bridge satisfactorily for repair or removal; and the dovetails giving a treacherous hold, especially in the green woods likely to be used in field practice. In lieu of these, couplings should, as much as possible, be made by mere fishings, covering and steadying the abutments,—by the simplest kinds of keyed scarphing,—or by iron strapping, if obtainable.

Troops should seldom be allowed to keep step in marching over Field Bridges, as they are rarely stable enough to bear the accumulating oscillations thereby produced.

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* Vide Corps Papers, vol. iii. p. 163.

A small iron Suspension Bridge was not long ago carried away, by the neglect of the Officer in command of a detachment to give the word 'March at ease.' They who have been stationed at St. John's, Montreal, will remember how advisable this precaution was in crossing the Richelieu by the long feeble wooden bridge built on the resources of a private speculator.

BRIDGE, FLYING, SWING.—Plate XIII. figs. 1 to 5.

Such Bridges, as well as those of Boats, are frequently used on the Rhine—a river on which permanent structures would be objectionable in certain military points of view, as well as in those of a mercantile nature, as impeding the great timber rafts which are constantly floated down from upper Rhine as long as the river remains free from ice.

In this description of Swing Bridge, the necessary obliquity to the stream is given by the rudder. Fig. 1 shews the Bridge in plan as it swings from side to side at the lower end of a mooring chain, about 650 yards long,* the upper end being well fixed and anchored in the centre of the stream, and the intermediate length supported on boats.

The wharfs which receive the Bridge on its arrival are moveable, and so arranged by floating them on boats like those of the Bridge, that they can be adjusted to any state of the waters; there is a difference of 30 feet between the extreme levels at Bonn.

References. Fig. 1.

a, the platform, say 3″ pine planking on rafters 8″ × 8″ and 4 feet apart, lying across the boats; ends projecting 4 feet beyond the outer sides. The boats are very strong, decked, and nearly flat-bottomed; they bear the platform as it rests upon the deck, about 5 feet above the water.

b,† the horse on which the mooring rides and traverses; the traversing beam is under, and parallel to, the top beam.—Vide fig. 2.

c, from the adjusting windlass, *c* to *o*, the mooring is a 9″ hawser; but from *o* to the pivot, a chain composed of bar links 2 feet long, and connecting rings; both links and rings of about ¾″ square bar iron.—Vide fig. 3.

The length of the mooring depends on the width and velocity of the stream; but it is not customary to make it less than the breadth of the river. At Bonn, between the Bridge and pivot, it rest on 9 boats.—Vide fig. 4.

d, d, rudders.

e, e, battens nailed to the deck, to which the steersman stays that tiller at which he does *not* stand, by means of a sort of boat-hook.

f, f, cross-beams, a few inches above the deck, which with the heads *g*,

g, g, serve for belaying, &c.

h, h, small capstans to check the Bridge when it arrives at the wharf, as well as to bring it up square alongside of this last; a 6″ rope is used for this. The checking is

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* According to the Belgian Engineer Regulations relative to Field Bridges, the length of the chain should be not less than 1½ width of river.

† In the Swing Flying Bridge over the Oder, (between Freienwalde and Stargard,) instead of a 'horse' there is a mast; and in lieu of one chain mooring in the stream there are two 3-inch ropes fastened near the top of the mast, which are wound up on each bank by horse power, (to assist the stream and rudders,) on weams, alternately, as the ferry moves from side to side. The Oder is here about 100 yards broad, and is crossed in about 6 minutes.

also assisted by letting fall a drag-board, which hangs ready across the bows, at *g*, *g*, as soon as the Bridge comes within a few yards of the side.

i, *i*, little wooden rollers, set vertically in the framing of the railing.

j, connecting beam.

k, *k*, hatches.

l, seats for passengers.

m, *m*, railing.

n, *n*, entrances.

o, point of junction of cable and chain in the mooring.

p, *p*, anchors in case of accident: a row-boat is likewise attached to the Bridge.

In the winter, should there be much drift ice, these Bridges become useless; their place is then supplied by common ferry-boats.

The preceding account is that of one of the largest bridges: fig. 5 refers to one of the smaller class, at Linz, also on the Rhine.

It consists of only a single boat about 12 feet wide, and perhaps 30 feet long.

The oblique direction in this sort of Swing Bridge is given by the chain *d*, *b*, *e*. *a*, *b*, *c*, is the mooring.—*d*, *b*, *e*, a small chain passing through a block at *b*, and wound up at *d* or *e*, according to the side to which the boat is moving. To assist the conversion of the direct force of the stream into the necessary oblique one, 4 small 'lee-boards' are slung at the sides at *f*, *f*, *f*, *f*.—*c*, *g*, is a 'horse' as in the preceding, but the mooring is fixed only to the post *c*.—*h*, *h*, gang-boards let up and down like a drawbridge, from the 'horse.'

N.B.—*b* is in the last boat supporting the mooring.

BRIDGE, FLYING, TRAIL.—Plate XIII. figs. 6 to 9.

The figure is taken from the Règlemens Provisoires of the Belgian Engineers. Such a flat-bottomed boat as fig. 5, which is easily constructed, would also be applicable: in default of boats, a light raft* must be substituted.

In the old Flying Bridge at Plymouth, there was no intermediate sling, *d*, *b*, *e* (fig. 5); but the boat slid along a 6-inch sheer-line, received on board, and led along 2 rollers (figs. 8, 9), close under the gunwale on one side. The boat was moved across by 2 men constantly walking forward, and warping on the rope by a short wooden bat, with a deep notch in it, sufficiently large to take a hold; each man returning aft as soon as he reached the head.

The following somewhat novel, and apparently effective, resource in crossing rivers, may very appropriately close this series,—as the Flying Bridges just described are virtually ferries.

"The mode in which we passed the Oxus was singular, and, I believe, peculiar to this part of the country. We were drawn by a pair of horses, who were yoked to the boat on each bow, by a rope fixed to the hair of the mane. The bridle is then put on, as if the horse were to be mounted; the boat is pushed into the stream, and, without any other assistance than the horses, is ferried directly across the most rapid channel. A man on board holds the reins of each horse, and allows them to play loosely in the mouth, urging him to swim; and thus guided, he advances without difficulty. There is not an oar to aid in impelling the boat; and the only assistance from those on board consists in manœuvring a rude rounded pole at the stern, to prevent the vessel from wheeling in the current, and to give both horses clear water

* Blanshard's Pontoons are perfectly applicable in this case, figs. 6, 7, Plate XIII.

to swim. They sometimes use four horses; and in that case two are fixed to the stern. These horses require no preparatory training, since they indiscriminately yoke all that cross the river. One of the boats was dragged over by the aid of two of our jaded ponies; and the vessel which attempted to follow us without them was carried so far down the stream, as to detain us a whole day on the banks, till it could be brought up to our caravan. By this ingenious mode we crossed a river nearly half a mile wide, and running at the rate of three miles and a half an hour, in 15 minutes of actual 'sailing;' but there was some detention from having to thread our way among the sand banks that separated the branches. I see nothing to prevent the general adoption of this expeditious mode of passing a river, and it would be an invaluable improvement below the Ghats of India. I had never before seen the horse converted to such a use; and in my travels through India I had always considered that noble animal as a great incumbrance in crossing a river."—Burnes' 'Travels,' vol. ii. page 216.

BRIDGE.—Reconstruction of.

Communications may be re-established by all the preceding modes of passing rivers; those which seem most applicable to the repairs of broken arches, are the simpler kinds of Spar Bridges, Plate X., and Rope Bridges, Plate IX. At Dresden, Laisné states, that well-secured flat boats, bearing high trestles, were used as temporary piers. Where stability can be insured, a simple 'horse'* may be substituted for the trestle.

With reference to construction, as well as repair, of Bridges, experience has shewn that in demanding labour and material, contingencies are not too high at cent. per cent.

BRIDGE, Field.—Demolition of.

An enemy's Bridge can be destroyed by sending trunks of large trees,—or considerable quantities of small ones, to accumulate faster than he is likely to be able to remove them, so as to throw a strain on his cables;—or by heavy floats loaded with stones, having a short and strongly-fixed mast to prevent it from passing under the Bridge.

These may or may not be combined with fougasses, in the shape of powder-boxes, arranged with a gunlock, or a pistol inside, fixed to a projecting pole or poles, so as to explode on striking the boats, &c.

If any of the above be furnished with shells or grenades, to deter men from approaching, care must be taken to cut the portfires so as to explode at uncertain intervals.

These attempts should of course be made, if possible, at night, from the nearest accessible point; and on having ascertained the set of the current as nearly as may be. —*Chiefly from Laisné.*

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* For a figure of this sort of 'horse,' see Plate XIII. fig. 2; it is a two-legged trestle.

BRIDGE, MASONRY.*—DEMOLITION OF. Plate XIV.

In the destruction of Bridges during the Duke of Wellington's campaigns, various methods were adopted, according to the circumstances of the case.

The Bridges in the Peninsula were usually of stone, the arches from 20 to 40 feet span semicircular, and of one stone of 18 inches or 2 feet in thickness. The loading of the arches was sometimes of solid masonry, but commonly of loose stones or rubbish.

The object required generally was to destroy one arch; and in order to give the enemy the greatest inconvenience and delay, the largest arch, and where there was deep water, was preferred, excepting when want of time or ammunition made it advisable to select a particular one that might appear weaker than the others.

The simplest principle of mining a Bridge was found to be by lodging the powder on the haunch of the arch, and as near as could be on the centre of the width of the Bridge, with the line of least resistance through the arch.

The best mode of forming the mine was where the side walls of the Bridge above the piers were slightly built and easily got at, and the loading of the arch of loose rubbish: a small gallery was then run in A, Plate XIV. fig. 1, about 5 feet from the arch stone; and when at the centre of the width of the Bridge, a return was made to the arch, and the powder lodged against it. There are not many occasions where this can be done under a very considerable time; but when practicable, it has many advantages: the greatest resistance is obtained to the sides and above; the ammunition is less likely to get injured from wet penetrating to it; there is no obstruction to the road over the Bridge while preparing, and less danger of accidents after it is loaded.

In this case, the powder, saucisson, &c., are applied in the usual manner in mining; and the end to be lighted is kept within the surface of the wall, to be sheltered from the weather.

The common and quickest mode of mining a Bridge is by sinking down from the road above to the arch, and lodging the powder in one mass on the centre of its width. To do this with good effect, the shaft, C, B, fig. 2, should be sunk where there will be the greatest resistance gained above and to the sides, as at B. As the arch gives so much more resistance than the materials with which it is loaded, the distance to the surface, therefore, should be two, or three, or even four times more, at least, in those directions, than in that through the arch, in proportion to the nature of those materials.

In this way arches have been blown down with 45 pounds of powder, and after five or six hours of labour.

The shaft should be sunk on one side of the centre of the width of the Bridge, as at C, fig. 3, and a little return made at the bottom to gain that situation for the powder, by which means there will be more solid resistance above, and a greater width of road left open during the operation.

In loading, the saucisson was brought up the shaft to within about 1 foot of the surface of the road, and then carried along a gutter or drain to the side of the Bridge where it was lighted, whereby the road was entirely cleared, and a premature explosion from accident less likely to occur. The upper surface of the road was drained off as much as possible, to keep the wet from penetrating to the powder.

When there is no time to sink a shaft as deep as might be wished, as great resistance must be obtained as can be, by sinking as deep to the arch as there is time for,

* The whole of this Paper on Demolition by Major-General Sir J. F. Burgoyne, R.E.

and increasing the effect by a loading of as much stone or other heavy materials from the parapet walls or elsewhere as can be applied.

A Bridge across the Carrion, at Dueñas, was required to be mined in great haste, and it was found that the loading between the arches was of solid masonry: an opening was therefore made down to the crown of the arch, D, figs. 4 and 5, about 2 feet 6 inches only; 250 lbs. of powder were lodged in rather a longitudinal direction along the width of the Bridge, and a loading, C, C, fig. 4, applied of heavy stones and rubbish, as high above the road of the Bridge as could be, without preventing carriages from passing: when fired, it made a gap, E, E, E, E, across the Bridge of 15 feet, which was about half its span.

The French declare, that 100 pounds of powder, laid on the crown of an arch, and without loading, would destroy it; but, in a well-built Bridge, I should be sorry to apply so small a quantity.

As on service the time at command for this kind of operation is very uncertain, it is a common and good mode to commence preparing in two places, one on the crown of the arch, and the other on the haunch; and then, if not allowed time sufficient to complete the latter and better mode, the powder can be applied on the crown of the arch, and exploded with or without a loading of rubbish, according to circumstances; and it is much better to do that than to lodge the powder in a shaft only partly sunk down to the haunch, although it should be deeper.

In some cases where the Bridge is very wide, and the operation can be carried on with nicety, it may be right to divide the powder into two mines, F, and G, fig. 6, across its width; but in a rough operation, I would certainly never divide the powder; for although it was said once that a hole was blown through the centre of a wide arch, and a passage left on each side (which, however, I do not believe), if it was so, certainly that same quantity of powder that gave so nice a shock, would not have injured the arch at all, if divided.

I have seen an instance where about half of the width of a Bridge, F, G, H, fig. 7, was blown down, which probably arose from dividing the powder in this manner.

There can be no reason whatever for dividing the powder between the different sides of the arch, as at I, K, fig. 8; by doing so, a failure took place on the Corunna retreat; and if it succeeds, there can be little doubt but that one of the mines would have done as well. Wherever the powder is divided, the explosion of the whole should be simultaneous; the arrangements require much precision, and the chances of failure are of course multiplied.

Where a Bridge is narrow, there can be no occasion for sinking the shaft down to the arch much deeper than half the width of the Bridge, as the want of resistance at the sides will render the additional vertical resistance superfluous. On one occasion, a failure occurred from a shaft being sunk down to a pier with the intention of destroying two arches; but which, although great perpendicular resistance was gained, blew out at the sides, and left the two arches perfect.

When the effect of a mine can be secured to cut through the arch, the greater resistance that can be given, even in that direction, the better, as it will increase the effect over the whole width of the Bridge.

As it generally happens on service, that the mine cannot be laid according to nice calculation, after applying it in the best way which circumstances will allow, the effect must be gained by increasing the quantity of powder. Under the chance of different difficulties that might occur, it was customary, when practicable, to send two, three, and even four barrels of powder, of 90 pounds each, for the destruction of a Bridge, although one would usually be sufficient.

When there was time, these mines were loaded with all the precautions commonly

BLANSHARD'S LARGE BRIDGE.

Fig. 1.

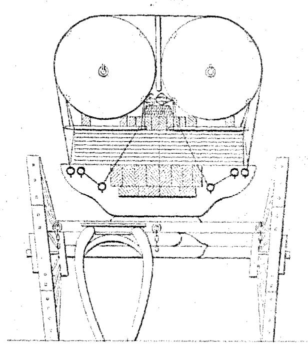


Fig. 2.

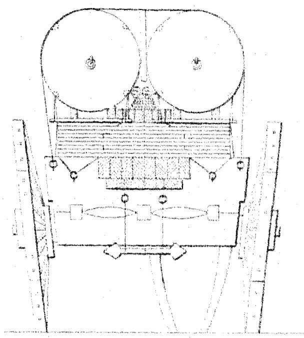


Fig. 3.

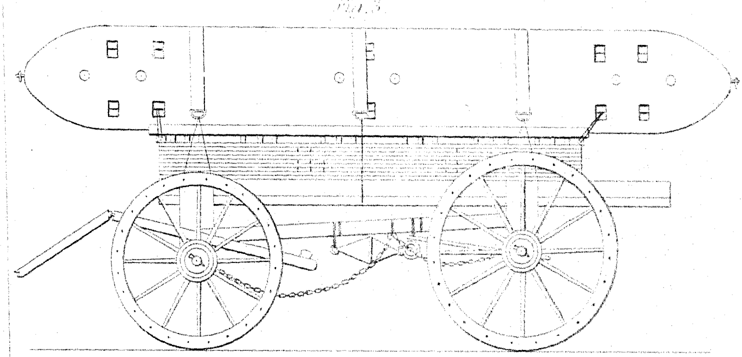
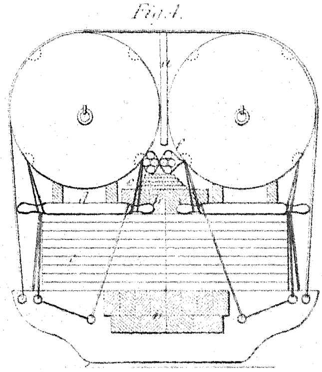


Fig. 4.



a. Bag filled with Sawdust &c.
b. Baulks and Sidepieces.
c. Chesses.
d. Saddles.
e. Table.
f. Oars and Boat hook.

John Weale, 59, High Holborn.

BLANSHARD'S LARGE BRIDGE.

Mooring Division

Reserve Division

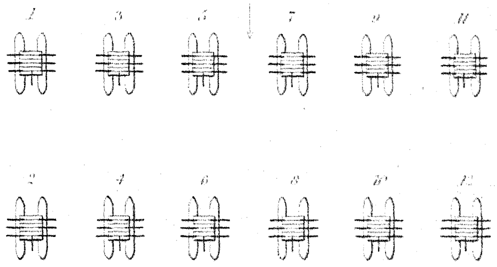


Fig. 2.

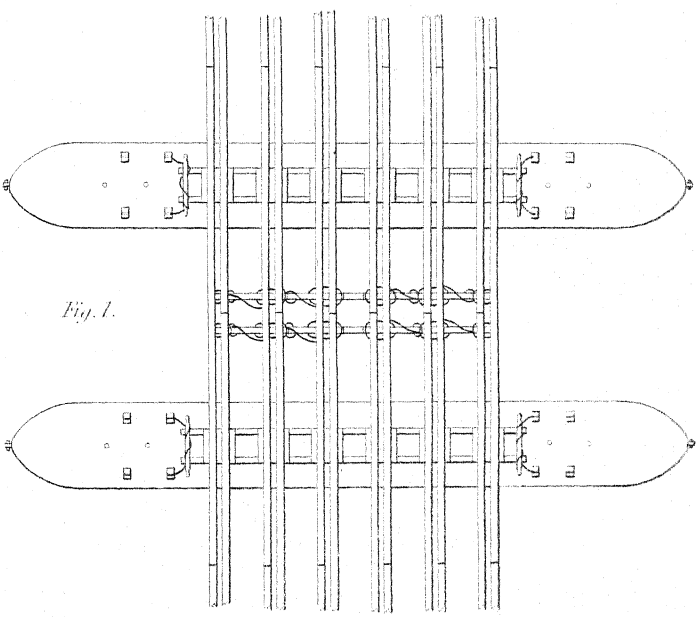
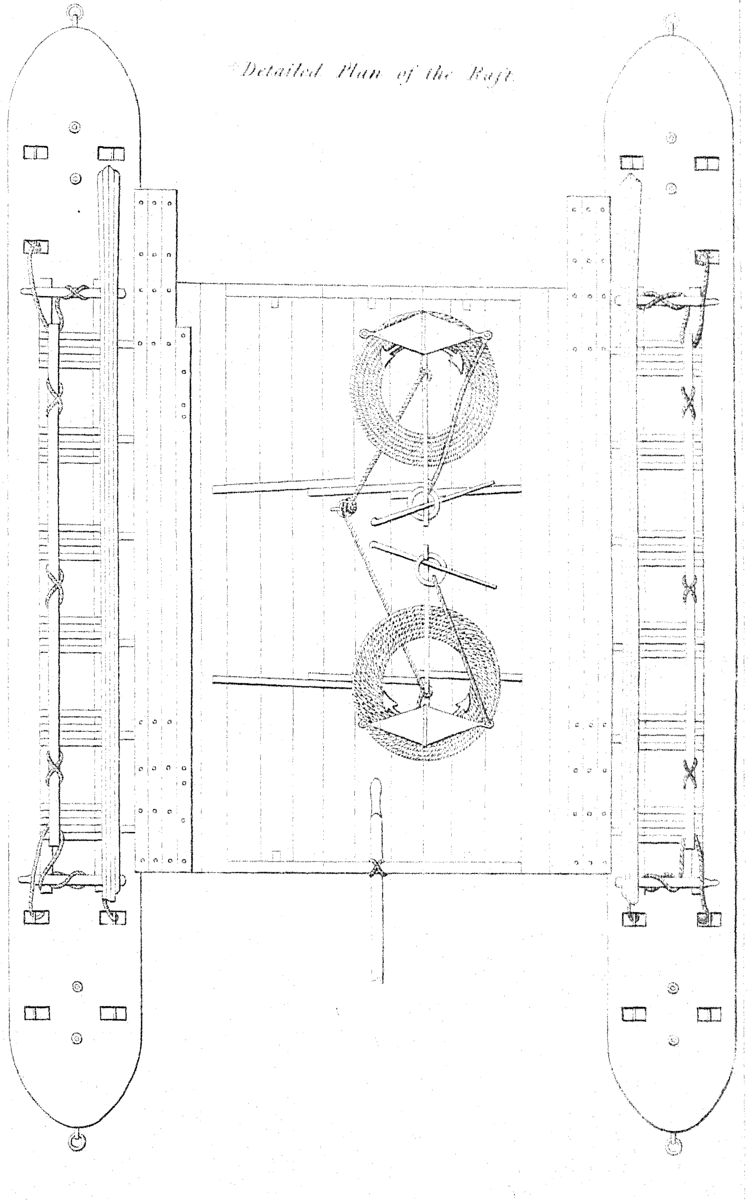


Fig. 1.

J.W. Lowry f.

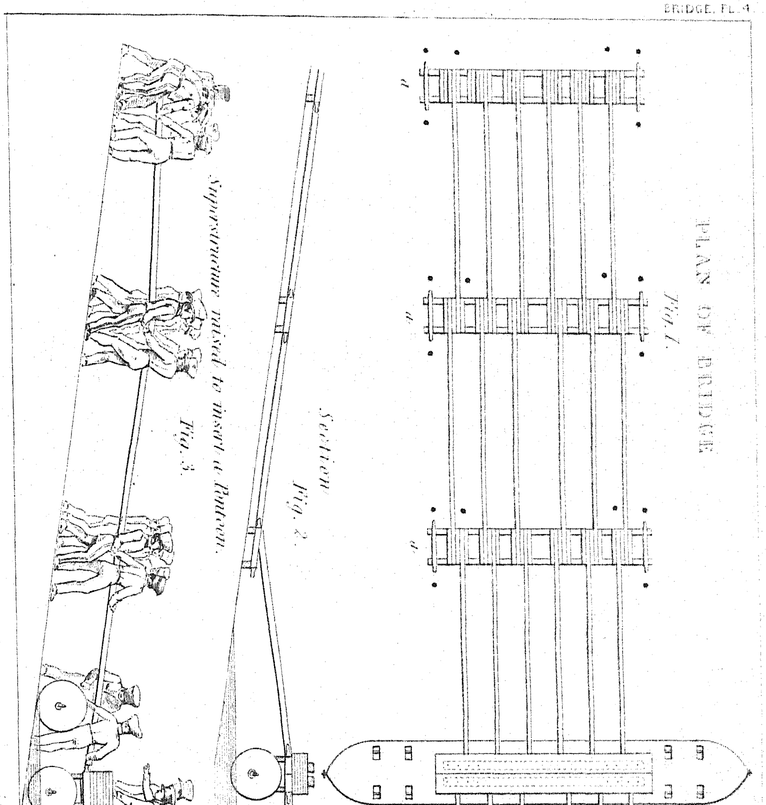
John Weale 59, High Holborn 1841.

BLANSHARD'S LARGER BRIDGE.



J. W. Lowry sc.

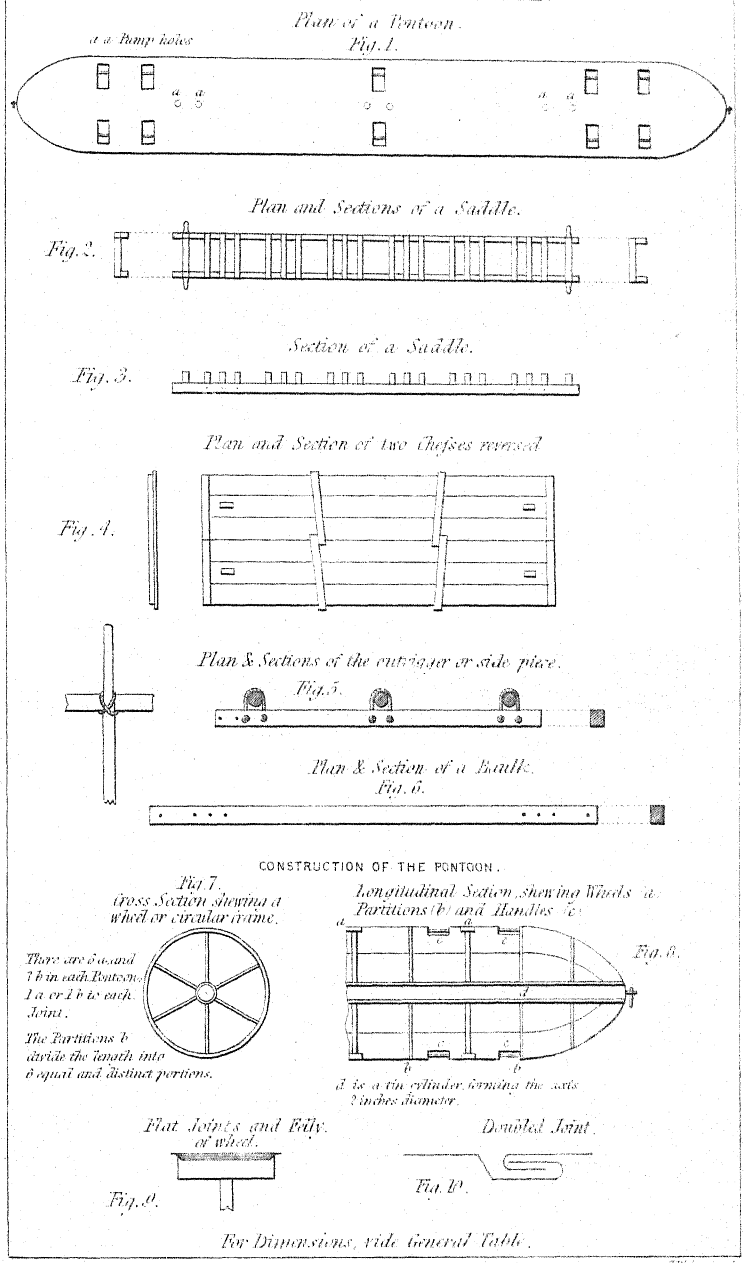
John Weale, 59, High Holborn, 1844.



J.W. Lowry fc.

John Weale, 59 High Holborn, 1844.

BLANSHARD'S LARGER BRIDGE.



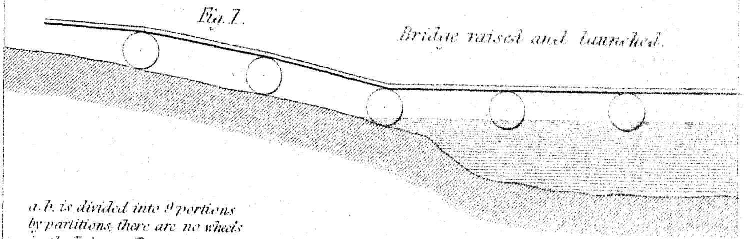
J. W. Lowry fc.

John Weale, 59 High Holborn, 1844.

BLANSHARD'S INFANTRY BRIDGE.

Fig. 1.

Bridge raised and launched.



a. b. is divided into 9 portions by partitions; there are no wheels in the Infantry Pontoon.

Fig. 2. Raft

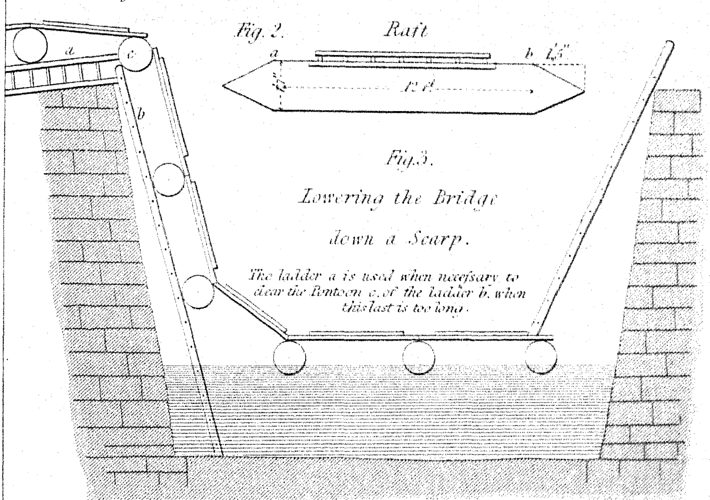


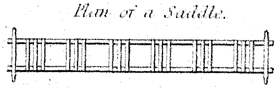
Fig. 3.

Lowering the Bridge down a Scarp.

The ladder a is used when necessary to clear the Pontoon c, of the ladder b, when this last is too long.

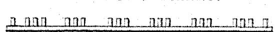
Plan of a Saddle.

Fig. 4.



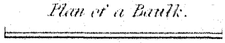
Section of a Saddle.

Fig. 5.



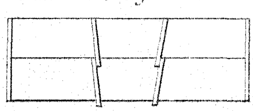
Plan of a Baulk.

Fig. 6.



Plan of two Chesses Reversed.

Fig. 7.

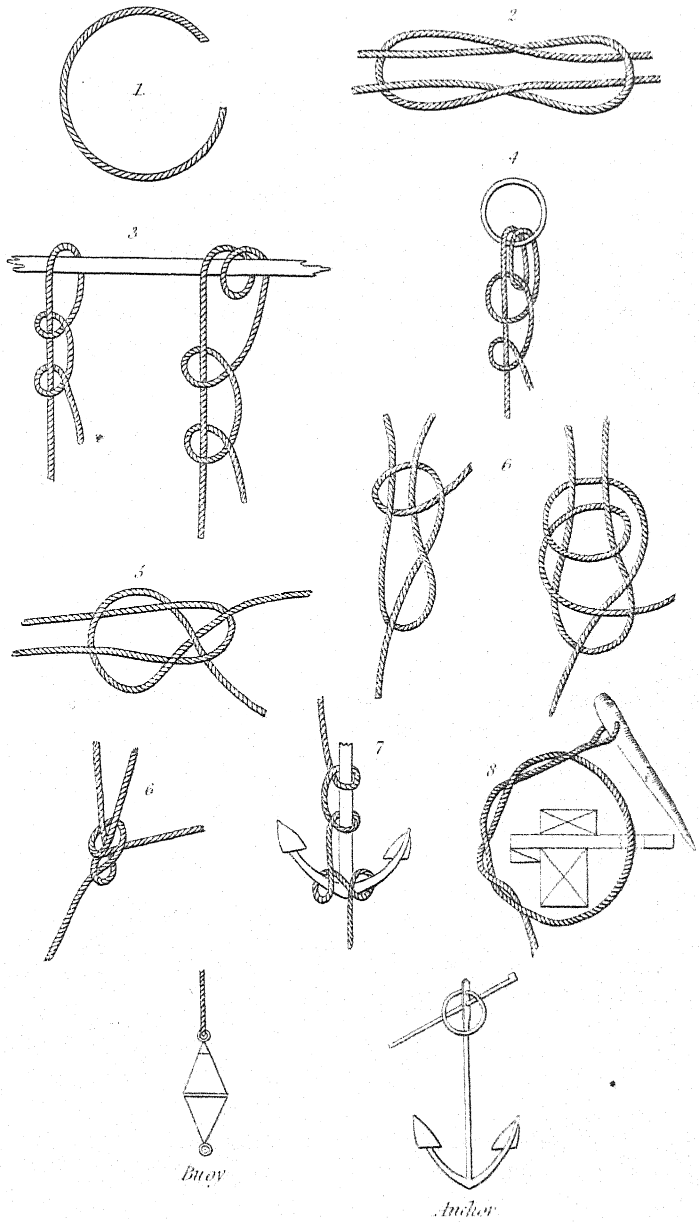


For Dimensions, see General Table.

J. W. Lowry, sc.

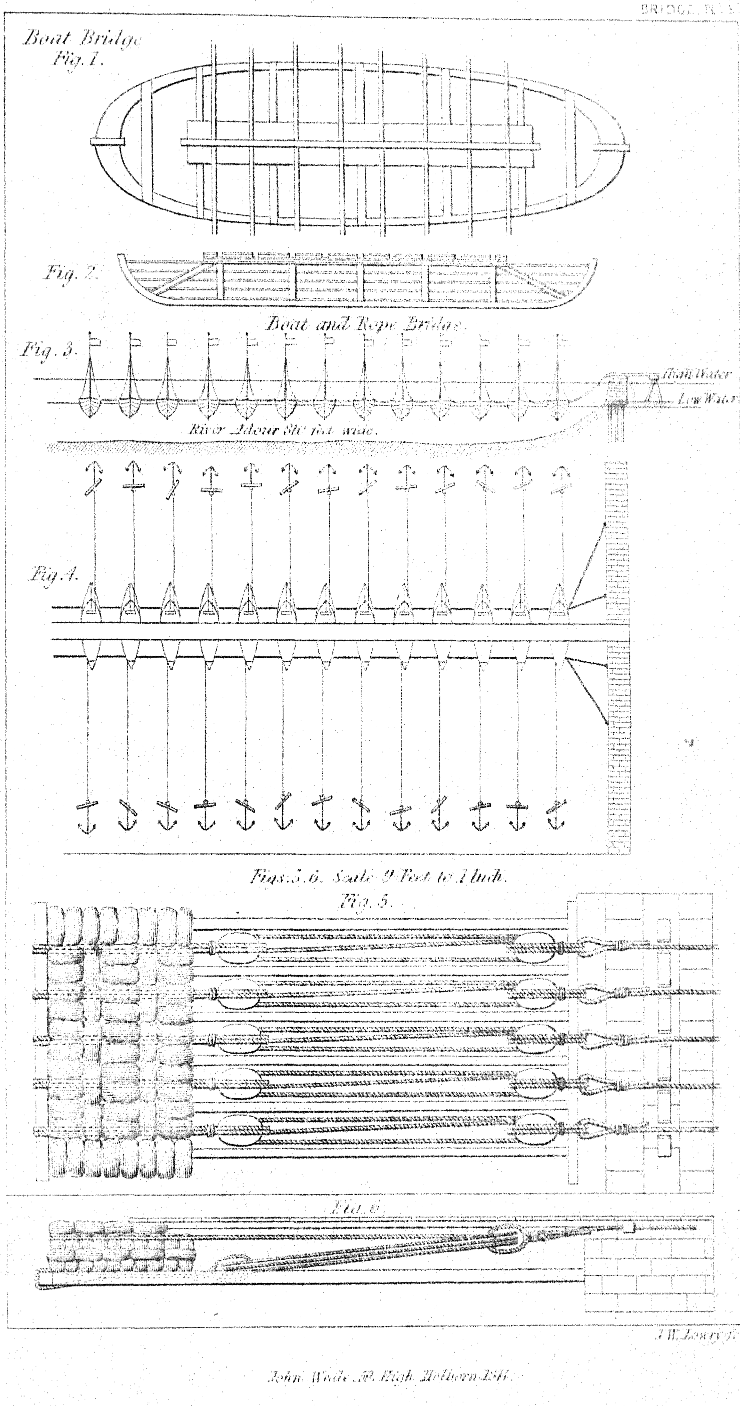
London John Weale, 1841.

BENDS, & KNOTS, USED IN PONTOONING.



J. W. Lowry, fc.

John Weale, 59, High Holborn 1848.

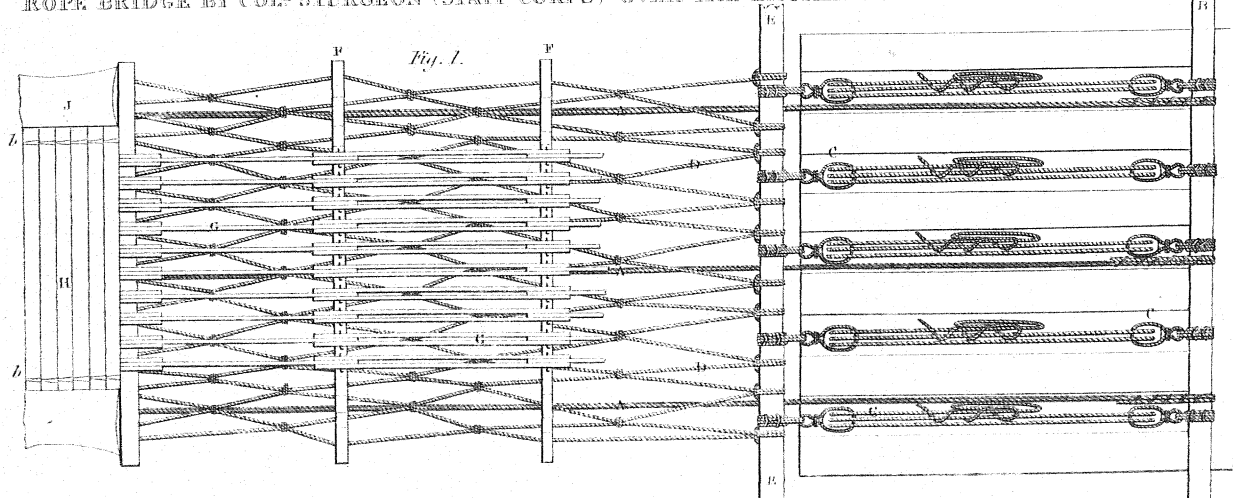


J. W. Lowry fc.

John Weale, 59, High Holborn 1841.

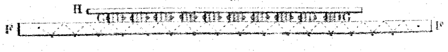
ROPE BRIDGE BY COL. STURGEON (STAFF CORPS) OVER THE BROKEN ARCH AT ALCANTARA.

Fig. 1.



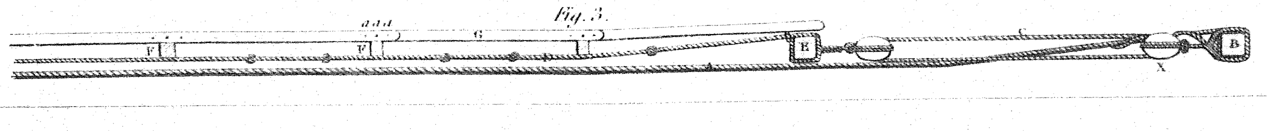
The Guys lead in the usual manner from the centre of the sides of the Bridge, to about 100 feet above and below them, on the Banks.

Fig. 2.



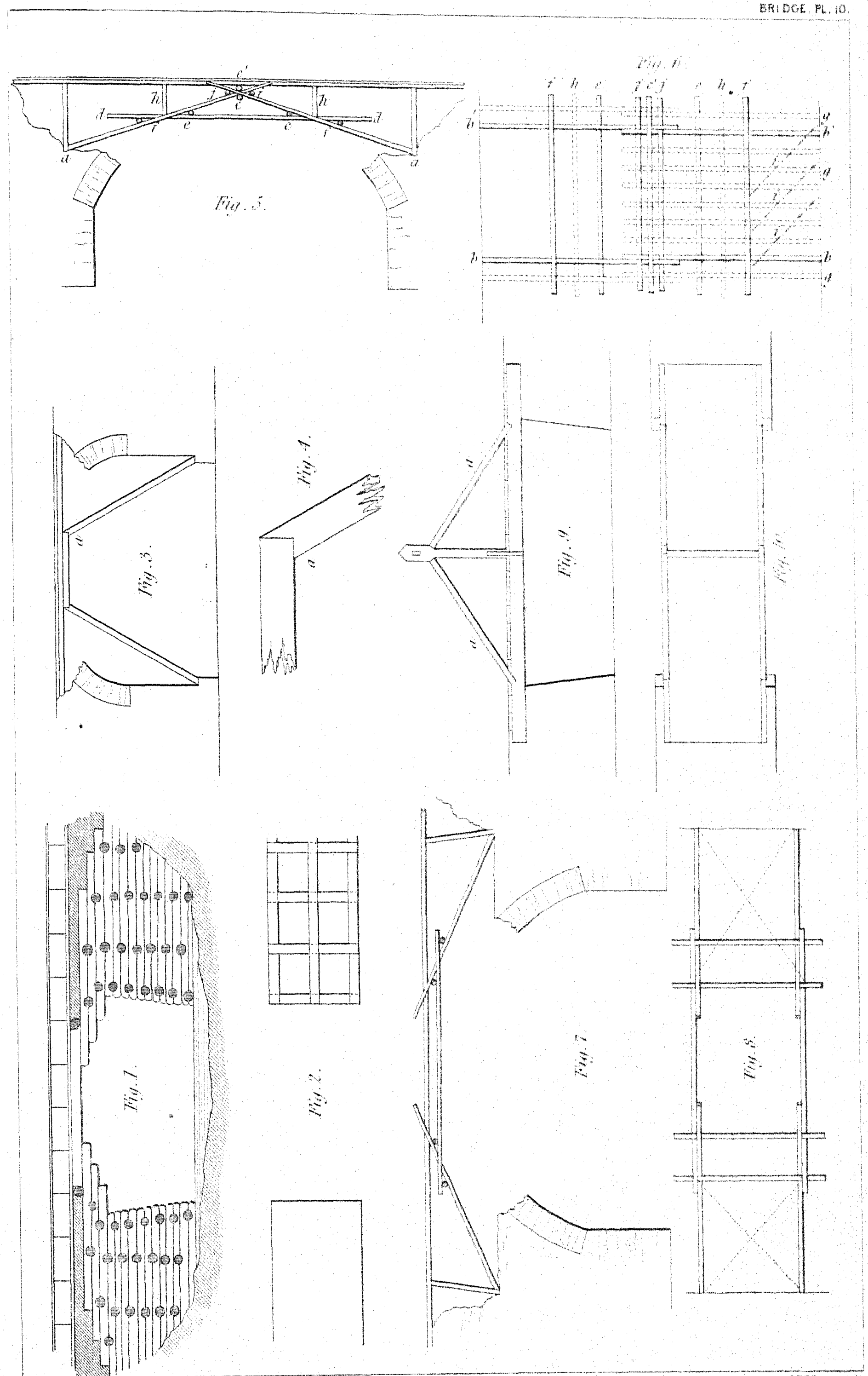
For dimensions, see General Table.

Fig. 3.



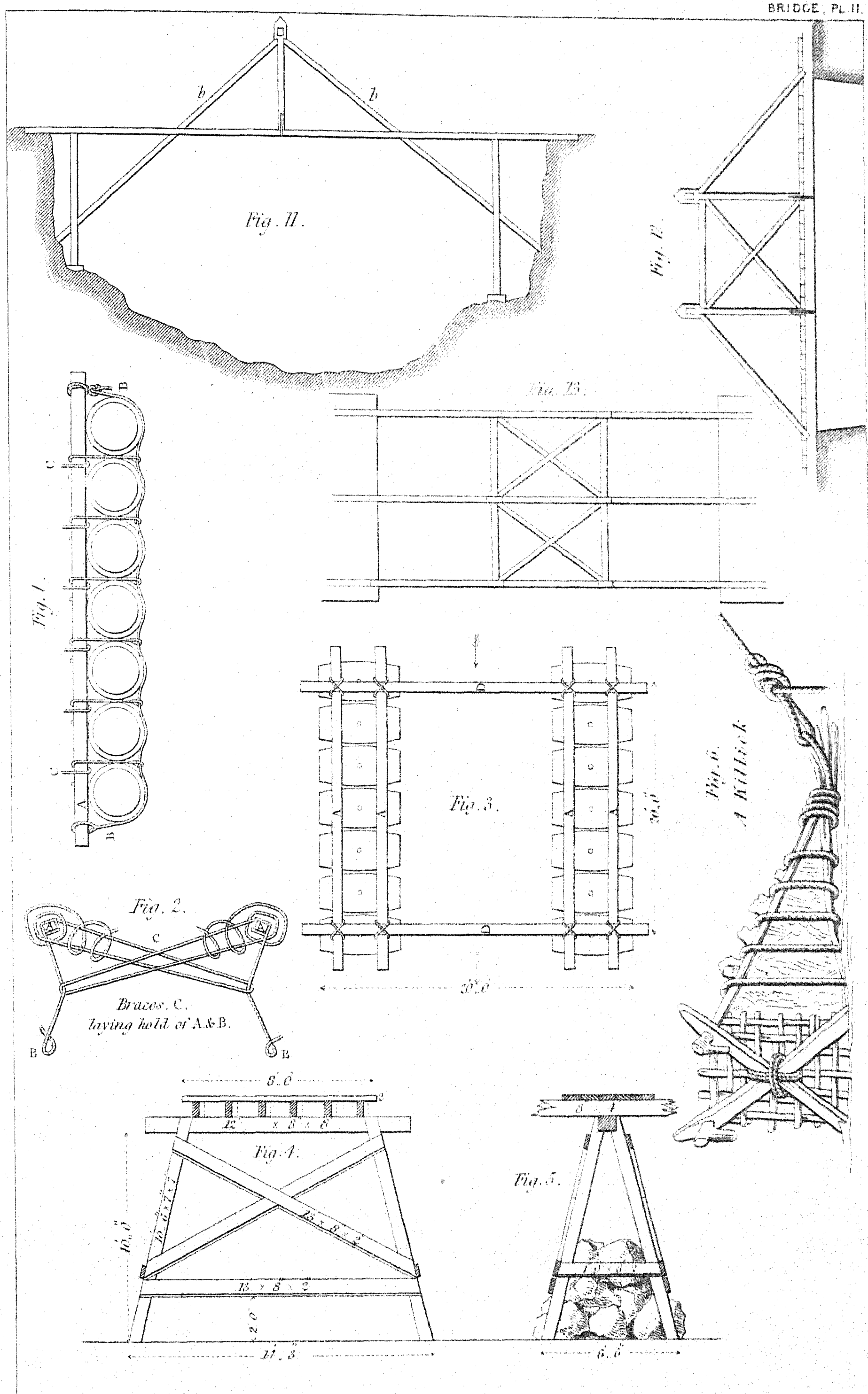
John Weale, 59 High Holborn. 1844.

BRIDGE, PL. 9



R.J.N. del.

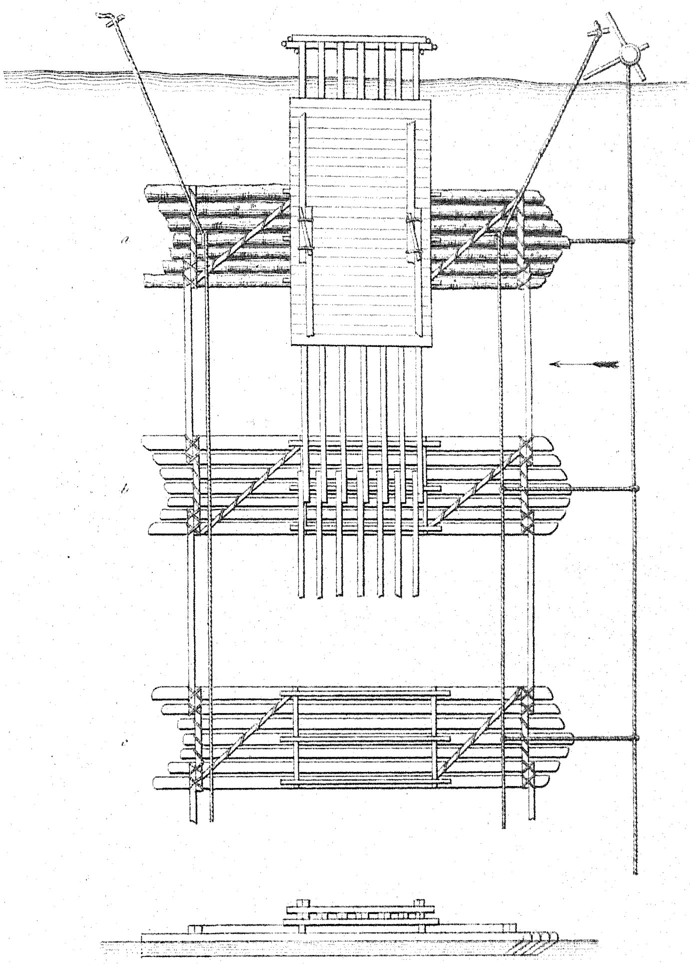
J.W. Lowry fc.



R.J.N. del.

J.W. Lowry fc.

RAFT BRIDGE.



Rafts b. c. may be either squared baulks or like a. of rough trees.
One or two tiers may be used according to circumstances.

John Weale 59 High Holborn. [illegible]

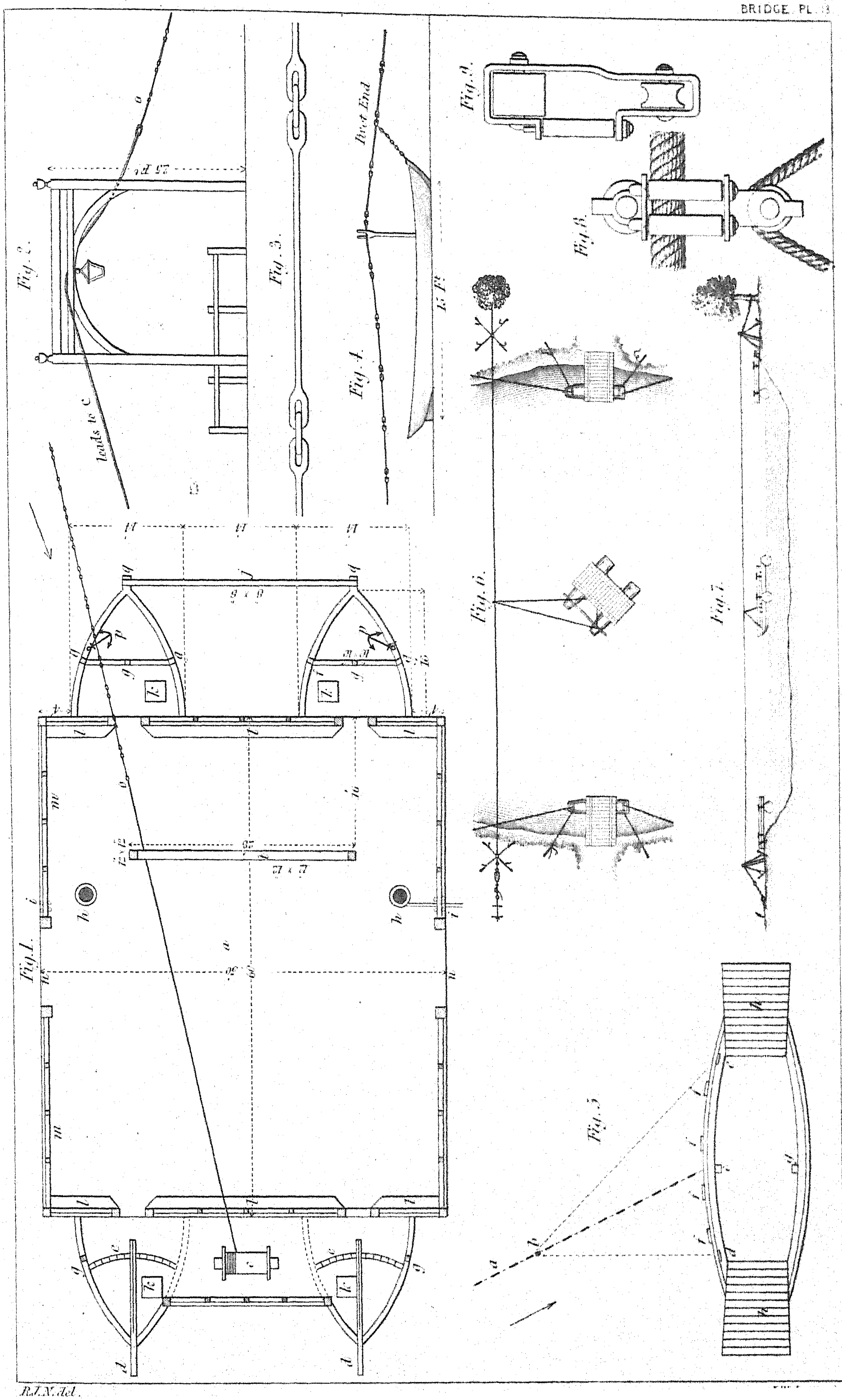
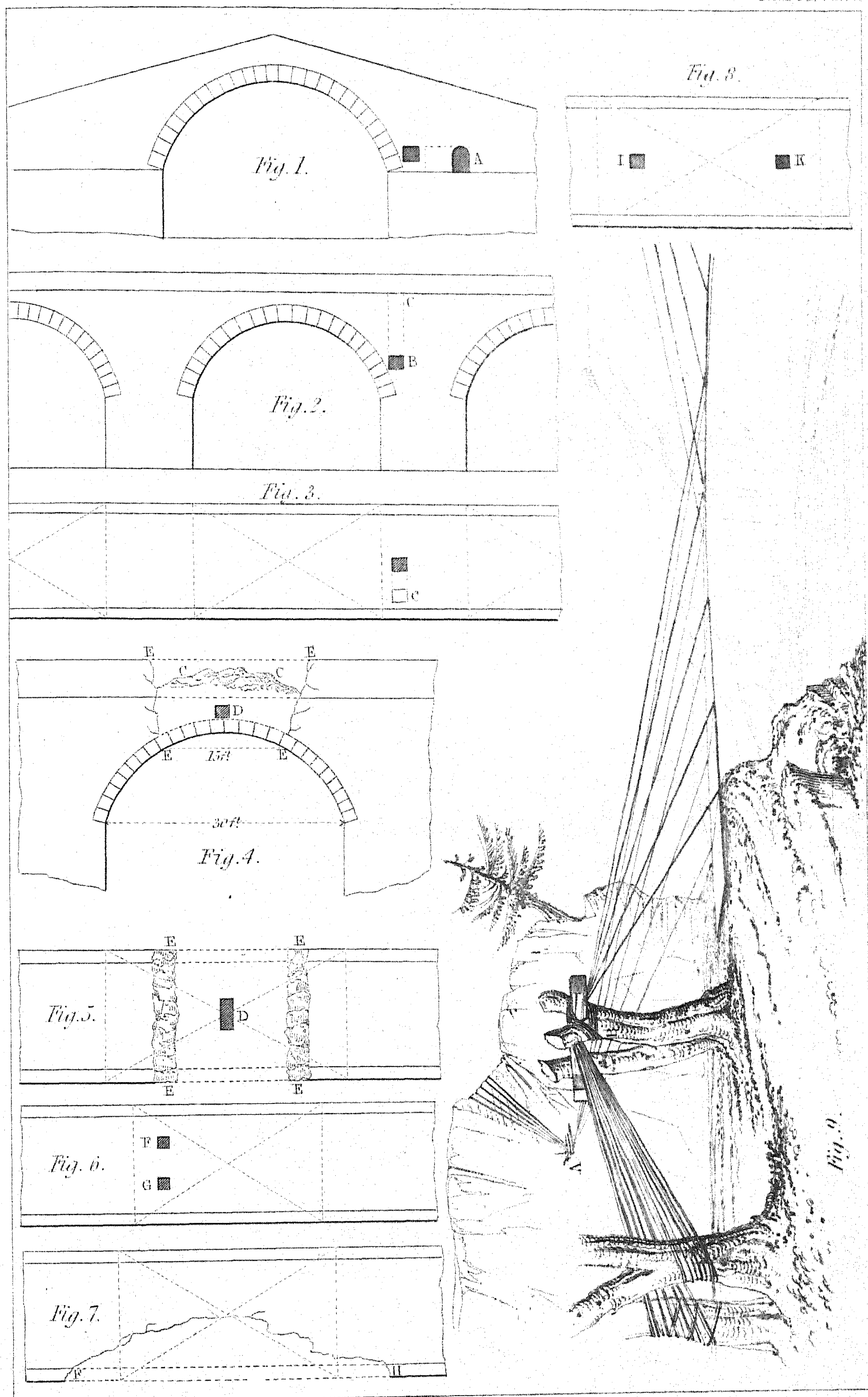


Fig. 1.
Fig. 2.
leads to c
25 Ft
Fig. 3.
Fig. 4.
Boat End
15 Ft
Fig. 5
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.

R.J.N. del.



R.J.N. del.

J.W. Lowry fc.

SOUNDS FOR MANŒUVRING A BRIDGE BY BUGLE.

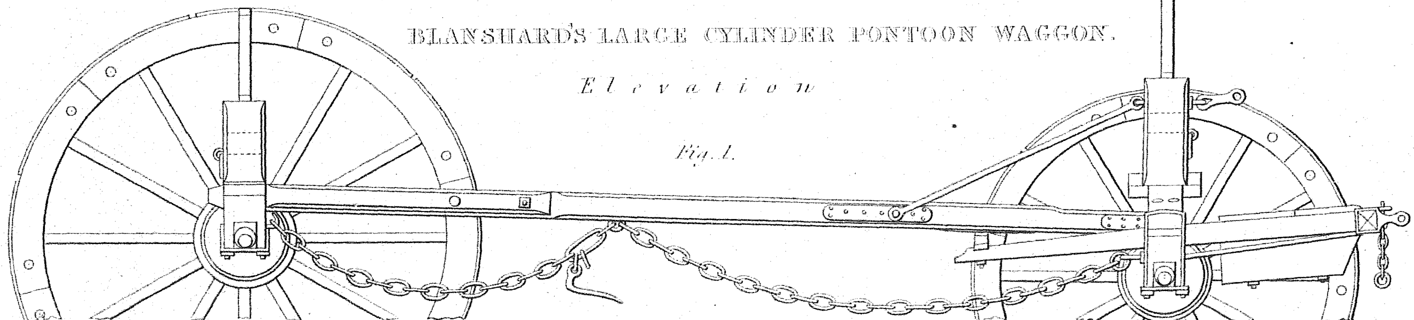
J.W. Lowry sc.

London, John Weale 59 High Holborn 1841.

BLANSHARD'S LARGE CYLINDER PONTOON WAGGON.

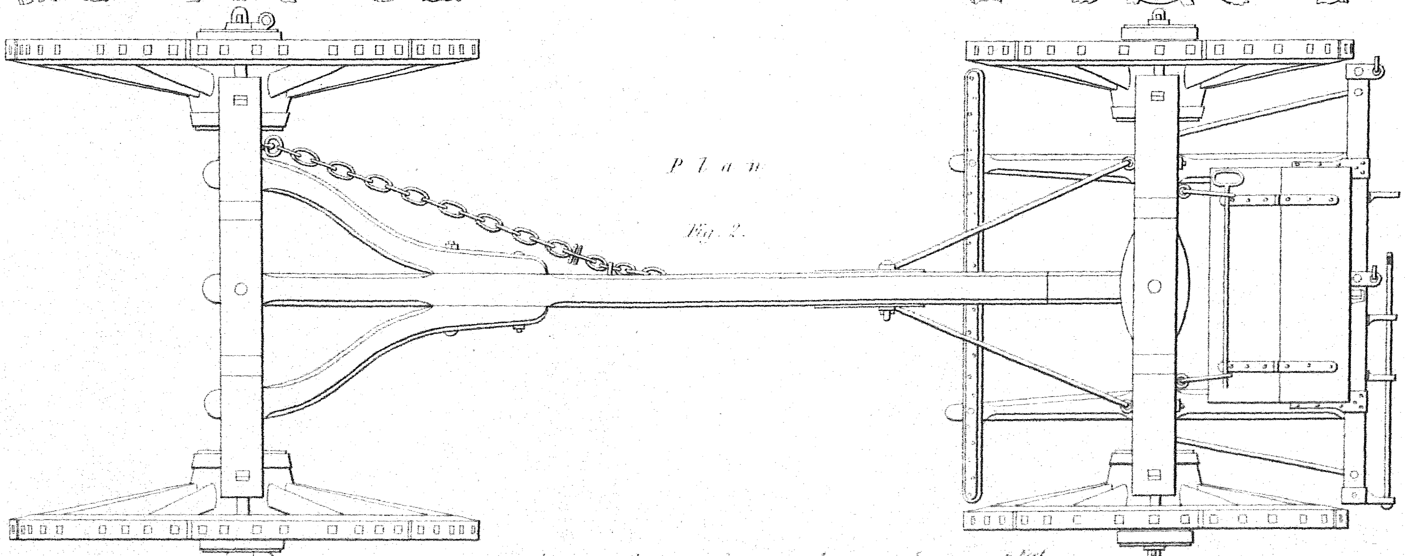
Elevation

Fig. 1.



Plan

Fig. 2.



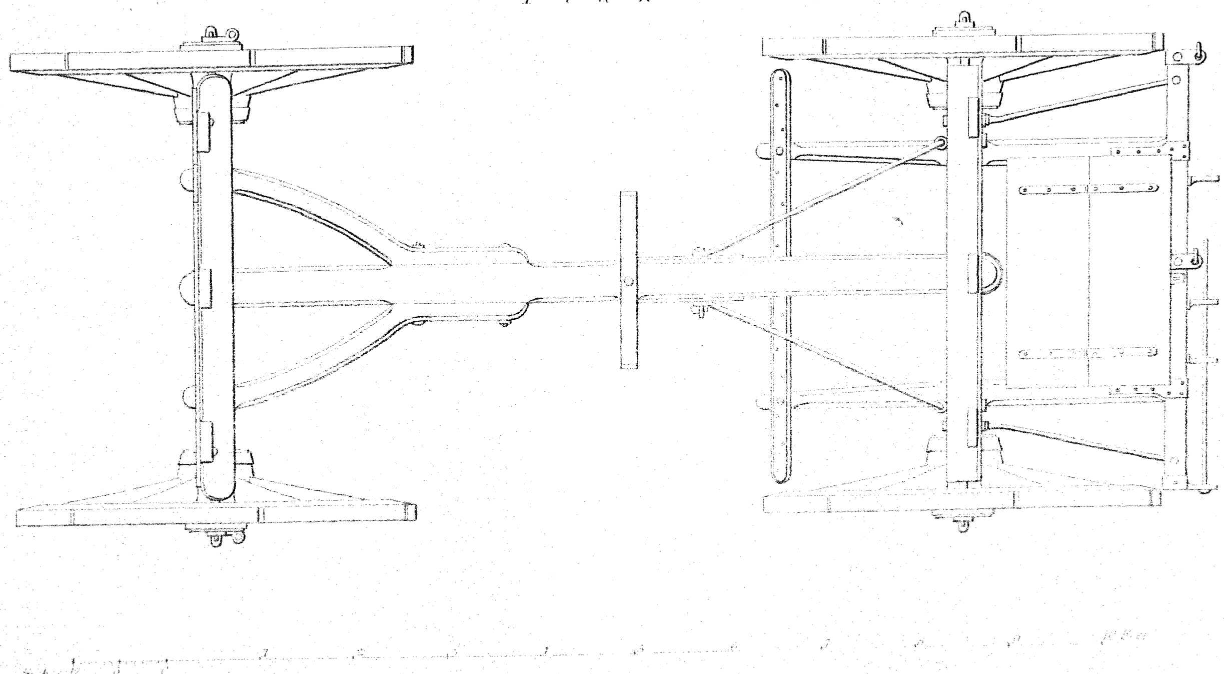
Inches 12 6 3 1 2 3 4 5 6 Feet

T. Hodgson del.

J. W. Lowry sc.

BLANSHARD'S SMALL CYLINDER PONTOON WAGGON.

Plan



T. Hodgson del.
Sergt. Royal Artillery.

used, viz., the powder in a box, and the saucisson in an auget; and when to ~~lay~~ lie any time, the box and auget were pitched, and covered with straw, tarpaulin, &c., to preserve the ammunition dry. When pressed for time, and without the proper articles, the powder was lodged in the barrels it was brought in, or laid in a tarpaulin, or in bags; and the saucisson was laid without an auget, but with care, that the stones or rubbish should not choak it. The mine was lighted by a piece of portfire tied into the end of the saucisson.*

Saucisson is so very easily made and carried, and so advantageous, that latterly we never failed having it with us; in our first mines, indeed, for want of it, we cut off the ends of portfires diagonally, and tied them together to pieces of stick the length necessary for train; but such a contrivance is very bad, and owing to it Lieutenant Davy was killed on Sir John Moore's retreat, the mine exploding the instant he lighted it, probably from the fire of the composition dropping down to the powder; for which reason, the end portfire should be laid horizontally, and a little clay round it will give additional security.

A small hollow, round the powder in a mine, will increase its effect.

DEMOLITION OF WOODEN BRIDGES.

To destroy wooden Bridges, powder was sometime used and applied to the most important supports in the arch, according to its construction; but as there is no other resistance than the air, the quantity of powder should be large: 90 pounds have blown down a strong wooden arch.

The common and best mode with a wooden Bridge is to lay the planking bare, and to light a large fire upon it, over the piles forming the piers, which will then burn to the water's edge, if left alone: but this will not do if the enemy cannot be kept from gaining possession of the Bridge for at least twelve hours after the fire is lighted.

BUFFALO.—Generally speaking, the Buffalo is seldom or ever employed for military purposes, being too slow, and impatient of heat.

BULLOCK.—In India the Bullock is used in drawing heavy guns, ammunition, and stores of every description.

It is likewise much used in heavy draught at the Cape, in trains ('spans') of from six to twenty, according to the nature of the road or work. It is said, there, that an ox can exist without water for four days; much less endurance gives it immediate preference, for the above duties, to the more sensitively-constituted horse, however inferior in speed and spirit. It will plod on unweariedly at from 2 to 2½ miles per hour, drawing from 3 to 4 cwt., exclusive of the long narrow waggon, over the roughest tracks conceivable, often more like the bed of a torrent than a road.

A serious item of consideration, in estimate of Ox establishments, lies in the heavy casualties to which, when over-worked and ill-fed, they are liable, from causes unavoidable, in the very country where the animal is most valuable.

As a Commissariat item of provision, the Devonshire Bullock averages from 4½ to 5½ cwt., net, carcass.

R. J. N.

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* Bickford's fuzes will, in many instances, prove a valuable improvement on the saucisson or powder hose; especially in exploding charges under water.

CABLE, CHAIN.

SIZES, WEIGHTS, AND STRENGTHS OF CHAIN CABLES* AND COMMON CHAIN.

Chain Cable.								Common Chain.			
Denomination from diameter of iron of the link, in inches.	Weight of stay pins.	Required Weight of cable.				Strengths.		Denomination from diameter of iron of the link, in inches.	Weight of 1 fathom.	Strengths.	
		1 fathom.	† Complete cable of 100 fathoms.			‡ Proof required.	Ultimate strength.			‡ Proof required.	Ultimate strength.
in.	oz.	lbs.	cwt.	qr.	lbs.	tons.	tons.	in.	lbs.	tons.	tons.
$2\frac{1}{4}$	40	272	243	,,	,,	$91\frac{1}{8}$	125·9	$1\frac{5}{8}$	155·7	31·6	73
$2\frac{1}{8}$	$33\frac{1}{2}$	242·75	216	3	,,	$81\frac{1}{4}$	112·3	$1\frac{1}{2}$		27	62·3
2	28	215	192	,,	,,	72	99·5§	$1\frac{7}{16}$		24·7	57·4
$1\frac{7}{8}$	23	189	168	3	,,	63	92·8§	$1\frac{3}{8}$		22·6	52·8
$1\frac{3}{4}$	$18\frac{3}{4}$	164·5	147	,,	,,	$55\frac{1}{8}$	74·1§	$1\frac{5}{16}$		20·6	48·4
$1\frac{5}{8}$	15	141·9	126	3	,,	$47\frac{1}{2}$	66·5	$1\frac{1}{4}$		18·8	44·1
$1\frac{1}{2}$	$11\frac{4}{5}$	120·9	108	,,	,,	$40\frac{1}{2}$	59·5§	$1\frac{3}{16}$		17	40·1
$1\frac{3}{8}$	9	101·6	90	3	,,	34	48·5	$1\frac{1}{8}$	74·8	15·3	36·3
$1\frac{1}{4}$	$6\frac{4}{5}$	84	75	,,	,,	$28\frac{1}{2}$	38·5	$1\frac{1}{16}$		13·6	32·7
$1\frac{1}{8}$	5	68	60	3	,,	$22\frac{3}{4}$	29·5§	1	64·9	12·0	29·3
1	$3\frac{1}{2}$	53·7	48	,,	,,	18	24·3§	$\frac{15}{16}$	56	10·5	26·1
$\frac{7}{8}$	$2\frac{1}{3}$	41·1	36	3	,,	$13\frac{3}{4}$	21·1§	$\frac{7}{8}$	45	9·1	23·1
$\frac{3}{4}$	$1\frac{1}{2}$	30·2	27	,,	,,	$10\frac{1}{8}$	13·5§	$\frac{13}{16}$	40	7·9	20·4§
$\frac{11}{16}$	$1\frac{1}{8}$	25·4	22	2	21	$8\frac{1}{2}$	11·4	$\frac{3}{4}$	34·5	6·8	17·3
$\frac{5}{8}$	$\frac{9}{10}$	21	18	3	,,	7	9·5§	$\frac{11}{16}$	29	5·6	14·6
$\frac{9}{16}$	$\frac{2}{3}$		15	,,	21	$5\frac{1}{2}$	,,	$\frac{5}{8}$	25·3	4·6	12 §
$\frac{1}{2}$	$\frac{5}{10}$	13·4	12	,,	,,	$4\frac{1}{2}$	6·0	$\frac{9}{16}$	20	3·8	9·7
$\frac{7}{16}$	$\frac{3}{10}$		9	,,	21	$3\frac{1}{2}$	,,	$\frac{1}{2}$	15·8	3·0	7·7
								$\frac{7}{16}$	10·6	2·3	5·9
								$\frac{3}{8}$	8·3	1·6	4·3
								$\frac{5}{16}$	5·8	1·1	3·0
								$\frac{1}{4}$	3·9	·75	1·9
								$\frac{3}{16}$		·42	1

STRENGTH OF PATENT WIRE ROPE.

Circumference.	Maker.	Breaking weight.
Inches.		Tons.
$4\frac{1}{8}$	Kuper and Co.	20
$3\frac{3}{4}$	Ditto.	$13\frac{1}{2}$
$3\frac{1}{2}$	Andrew Smith.	$14\frac{1}{2}$
$3\frac{1}{2}$	Ditto.	$16\frac{1}{2}$
$3\frac{1}{8}$	Kuper and Co.	$10\frac{1}{2}$
$2\frac{5}{8}$	Ditto.	$7\frac{1}{2}$
$2\frac{3}{8}$	Ditto.	7
$1\frac{1}{2}$	Ditto.	$2\frac{3}{4}$
1	Ditto.	$1\frac{1}{2}$
$\frac{3}{4}$	Ditto.	1

* From documents supplied by Capt. Denison, R.E., from official records. The strengths were tested by the hydraulic press at Woolwich, capable of giving a pressure of 120 tons. At that place, great pains are taken to obviate the chances of error to which these machines are liable,—by frequently testing the unit of power.

† Weight of 100 fathoms of cable in 8 lengths, including 4 swivels, and 8 joining shackles.

‡ Estimated at 630 lbs. per $\frac{1}{8}$ inch, in diameter, of the iron of the link.

§ Ascertained by altogether 67 actual trials.

As an accompaniment to the preceding Table, the Government specification for Chain Cables is appended. In the Plates will be found approved plans for shackles, couplings, &c., &c.

The weights given are the minimum allowed; and between this and the maximum the Contractor is allowed a latitude of $\frac{1}{15}$ in the $2\frac{1}{4}''$ chain, and of $\frac{1}{20}$ in all the rest.

The length of a link is 6 diameters of the iron used, and the breadth 3·6 diameters: thus the length in a $2\frac{1}{4}''$ chain is $13\frac{1}{2}''$, and the breadth 8·1.

It is to be observed that chains with stay pins are not so applicable to machinery as those without; in the Ferry between Devonport and Torpoint, most of the pins in the ground-chain flew out in a few weeks, as they passed at a sharp turn round the wheels.

SPECIFICATION FOR CHAIN CABLES.

The Iron Chain Cables are to be made in $12\frac{1}{2}$ fathoms lengths, with one swivel in the middle of every other length, and one joining shackle to each length, and of the weight specified in the Table.

The several sizes of Chain Cables being distinguished by the diameter of the iron of their common links, this diameter forms the unit of the scale of dimensions in the accompanying drawings, (vide Plate,) by which the dimensions of the various parts of the Cables of all sizes, and of the articles to be connected therewith, are to be proportioned. Thus, the length of a common link is to be 6 diameters, and its breadth 3·6 diameters, of its iron; and the length of an end link is to be 6·5 diameters, its breadth 4 diameters, and the substance of its iron 1·2 diameter, of the iron of a common link; and so on for all the parts of Cables of all sizes, and articles to be connected therewith, which are to be made as near as practicable to the dimensions shewn by the drawings, or specified herein, or in the accompanying Table.

The diameter, or transverse section of the iron of the links, and of the various parts of the swivels, shackles, and other articles to be connected with the Cables, is not to be less, taking the mean of the greatest and least dimension at any one section, than that specified herein, or in the Table, or shewn by the drawings. Also the length of the various links, swivels, shackles, and other articles, is not to be more than $\frac{1}{10}$th of the diameter of the iron of the common links over, nor their width more than $\frac{1}{10}$th such diameter over or under that specified or indicated as above mentioned.

The stay pins are to be of cast iron not exceeding the weights specified in the Table, and are not to be wider at their ends than the diameter of the iron of the links in which they are inserted, nor at their middle part than $\frac{6}{10}$ths of such diameter, meaning longitudinally, of the links.

Both the end links of every length of a Cable, as well as those of the mooring swivels, splicing tails, and splicing shackles, are to be made parallel-sided, without stay pins, and with the substance of their iron $\frac{2}{10}$ths of a diameter larger than the diameter of the iron of the common links of the Cable to which they belong, as shewn by the drawings, and so as to admit the joining shackles to be inserted or taken out of them in connecting or disconnecting any two lengths of the same, or of different Cables of the same size, by either end; also to receive the bolt of the large shackle for connecting any length of Cable of the same size, by either end, with the anchor.

The enlarged links connected with the end links, and with each end of the swivels, are to be made $\frac{1}{10}$th part larger in the diameter of their iron than the common links of the Cable they belong to, and with a stay pin in proportion.

The splicing tails of the different sizes, for connecting Iron and Hempen Cables together, are each to consist of one end link, without a stay pin, followed by one enlarged link, fourteen common links, and then another enlarged link, all with stay pins,

and all the before-mentioned links are to be of the same size as those of the Iron Cable, to which the splicing tail is to be attached; also of an egg-shaped link, no wider nor longer than necessary, of iron $1\frac{3}{10}$ths diameter of that of the common links, connected at its narrow end with the last-mentioned enlarged link, and at its broad end with three short-linked chains (without stay pins) called tails, the first link of each of which, connected with the egg-shaped link, is to be of iron, $\frac{8}{10}$ths the diameter of that of the common links. And the remaining links of each tail, about 65 in number, are to diminish gradually in size to iron of $\frac{1}{4}$ of the diameter of that of the common links before mentioned.

The steel tinned pins for retaining the joining shackle bolts, and the forelocks for the large shackle bolts, are not to follow the exact proportion agreeably to the diameter of the iron of the common links, laid down for other parts of Cables; but these articles, as well as the starting, and driving-out punches, are to be made as specified in the accompanying Table.* R. J. N.

CABLE, HEMP.†—All Rope is specified by its circumference.

The Cables, &c., referred to in the following Table, are made with the ordinary machinery hitherto used in the manufacture for the Navy.

The weights and strengths have been collected from different Dockyards; in many instances, in the 4th columns of Cable and Hawser, they have been obtained practically and experimentally; in the remainder they have been computed: in the 5th columns, the strengths are those given by the hydraulic press. All rope and cordage below $3\frac{1}{2}$ inches circumference was proved by dead weight. The strength of one tarred yarn, as the average of 31 experiments, is $147\frac{3}{4}$ lbs.: nearly one-half of this, and about one-third of the length, is lost in twisting.

In the manufacture of Cable-laid rope, the yarns are divided into nine equal parcels: each part, when twisted to an angle of 37°, is called a *lissum;* three lissums, wrought to the same angle, make one *strand;* and three strands, in like manner, make one Cable.

In Hawser-laid ropes, the yarns are divided into only three parcels, called lissums or strands; and these, when twisted again, form the Hawser. Hawsers are sometimes laid in four lissums; but under all circumstances, 3, or 4, they contain more yarns than Cables of the same size, and are harder laid.

The following reductions in length take place in the above-mentioned stages.

	10-inch cable.			10-inch hawser.		
Yarns,	504	of 152 fathoms.			648	of 152 fathoms.
Lissums,	9	142	,,	}	3	142 ,,
Strands,	3	118	,,	}		
Cable,	1	101	,,	1	3-str^d. Hawser,	113 ,,
					4 ,, ,,	106 ,,

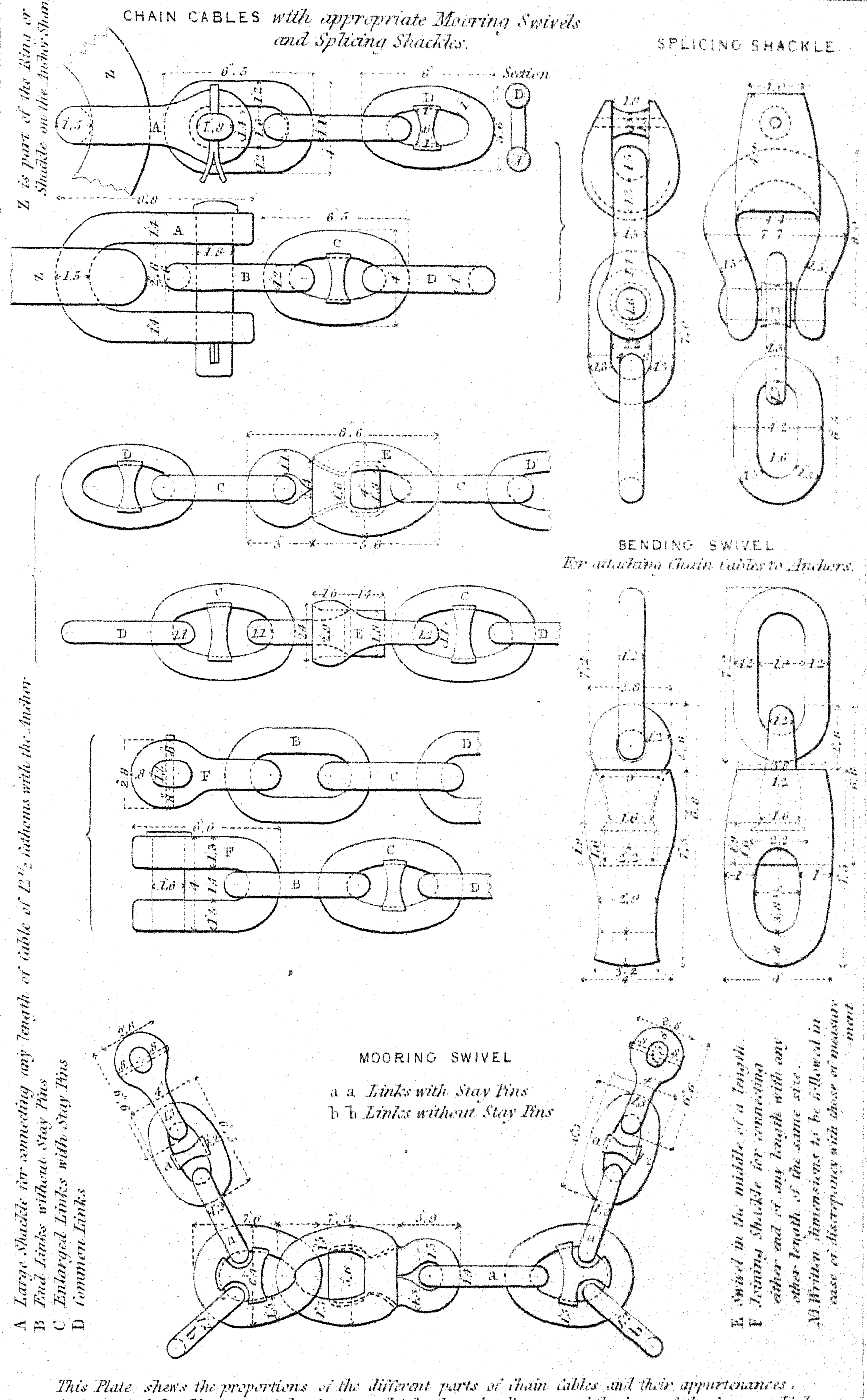
The present price of all cordage is about £40 per ton.

In the following Table, the strength of the 10″ Hawser is given at 21 tons; this was from actual experiment, but the Hemp for it was hatchelled finer than usual; 20 tons is a fairer average statement.

A discrepancy appears between the two last columns of the 'Cable-laid,' as well

* For all that is essential see the Plate. In the Table commencing this Article, several minutiæ of specification have been omitted, as unnecessary for general purposes.—R. J. N.

† From documents chiefly supplied by Capt. Burgmann, R.E.



This Plate shews the proportions of the different parts of Chain Cables and their appurtenances, in terms of the diameter of the Common Link: thus the diameter of the iron of the Common Link D, is 1; that of B is 1.2; the length and breadth of C, 6.5 & 4 times the diameter of the iron of D as the Unit.

J.W. Lowry fc.

as in 'Hawser-laid,' in which correction has not been attempted, as they are from different, and highly respectable authorities. It will be safest, generally, to take about two-thirds of the last column of Cable-laid as the practical strength for that description of rope.

Table of Weights and Strengths of Cables and Hawsers.

Cable-laid.					Hawser-laid.							
Circumference in inches.	Tarred.				Circumference in inches.	3 or 4-Strand; Tarred.					3-Strand; White.‡	
	Number of yarns.	Weight per fathom.	Strength of cables in tons.	Breaking weight, as obtained by actual trial.*		Number of yarns.	Number of strands.	Weight per fathom.	Strength of hawsers in tons.	Breaking weight, as given by actual trial.†	Number of yarns.	Weight per fathom.
In.	No.	lbs.	Tons.		In.	No.	No.	lbs.	Tons.	Tons.	No.	lbs.
26	3528	139·72	Not ascertained.		12	936	4	34·79	Not ascertained.			
25½	3384	134·01			,,	924	3	32·70				
25	3240	129·16	112·75	103·25	11½	852	4	31·62				
24½	3132	124·03	Not ascertained.		,,	852	3	30·15				
24	2988	118·94	103·00		11	781	4	28·00				
23½	2880	114·05	Not ascertained.		,,	780	3	27·61				
23	2736	109·24	95·00		10½	711	4	26·42				
22½	2628	103·58	91·00	97	,,	708	3	25·06				
22	2520	99·95	87·00		10	642	4	23·84				
21½	2376	94·57	83·00		,,	648	3	22·93	21·00		732	21·59
21	2268	91·07	79·25		9½	573	4	21·27	Not ascertained.			
20½	2160	85·97	75·75		,,	573	3	21·20	18·90		660	19·56
20	2088	82·69	72·00	76·16	9	521	4	19·37	Not as.	24·85		
19½	1980	77·78	68·25		,,	516	3	18·57	17·00		588	17·34
19	1872	74·55	65·00		8½	468	4	17·39	Not ascertained.			
18½	1764	70·00	61·50		,,	468	3	16·56	15·20		528	15·57
18	1656	66·90	58·25		8	416	4	15·45	Not ascertained.			
17½	1584	62·63	55·00	54·45	,,	408	3	14·67	13·40	22·03	468	13·81
17	1476	59·68	52·00		7½	364	4	13·50	Not ascertained.			
16½	1404	55·67	49·00		,,	360	3	12·89	11·80		408	12·03
16	1332	52·86	46·00		7	313	4	11·61	Not ascertained.			
15½	1224	49·13	43·25		,,	312	3	11·23	10·30		360	10·61
15	1152	46·46	40·50	42·55	6½	261	4	9·70	Not ascertained.			
14½	1098	42·98	37·75		,,	264	3	9·68	8·90		300	8·84
14	1008	40·47	35·25		6	226	4	8·39	Not ascertained.			
13½	936	37·25	32·75		,,	228	3	8·25	7·60	11·66	264	7·78
13	864	34·90	30·25		5½	191	4	7·09	Not ascertained.			
12½	792	31·93	28·00	31·4	,,	192	3	6·93	6·40		216	6·37
12	756	29·73	26·00		5	157	4	5·82	Not ascertained.			
11½	684	27·02	23·75		,,	156	3	5·73	5·30		180	5·10
11	612	24·98	21·75		4½	130	4	4·83	Not ascertained.			
10½	576	22·52	20·00		,,	130	3	4·64	4·20		144	4·24
10	504	19·96	18·00	17·5	4	114	4	3·83	Not ascertained.			
9½	468	18·53	16·24	15·	,,	108	3	3·67	3·40	6·34	108	3·18
9	432	17·10	14·58		3½							
8½	396	15·68	13·00		,,	78	3	2·80	2·60	6·22	84	2·27
8	324	12·83	11·52		3							
7½	288	11·57	10·00	10·25	,,	60	3	2·06	1·90	3·11	60	1·76
7	252	10·12	8·80		2½							
6½	216	8·73	7·60		,,	42	3	1·43	1·40			
6	189	7·44	6·48		2							
5½	162	6·25	5·44		,,	27	3	·92	·90			
5	135	5·17	4·50	4·27	1½	18	3	·52	·50			
4½	108	4·18	3·64		1	9	3	·23	·25			
4	90	3·31	2·88		¾	6	3	·17	·13			
3½	72	2·53	2·00									
3	54	1·86	1·64									

* This column was obtained from 95 actual trials at Woolwich, by the hydraulic press.

† This column also from 95 actual trials at Woolwich.

‡ The strength of white rope was not ascertained;—but it is always greater than that of tarred rope.

R. J. N.

CAMEL—with reference to Egypt, Syria, India, and the adjacent countries.

The Camel is used in the East as a beast of burthen from 3 to about 16 years of age, and in hot sandy plains, where water and food are scarce, is invaluable.

With an army, however, generally speaking, it is not so valuable as the mule or horse.

The Camel under a burthen is very slow-going, about half the pace of a mule, or from $1\frac{1}{2}$ to 2 miles per hour; he can, however, travel 22 out of the 24 hours, and only requires food once a day.

His load varies exceedingly in different countries. In Egypt it is as high as 10 cwt.; and for the short distance from Cairo to Boulac, even 15 cwt. is, I believe, sometimes carried.

But in Syria it rarely exceeds 500 lbs., and the heaviest load in the Engineer equipment for the Army of the Indus is stated to be 4 cwt. 48 lbs., independent of the pack-saddle. About 400 lbs. is a sufficient load on the march.

The pack-saddle or pad is secured in its place by the hump on the back, a hole being made in the pad to let it come through, also by a breast-plate and breeching; no dependence is placed on the girth, which is not kept tight.

The Camel, from his great size, averaging about 7 feet to the top of the hump, and 8 feet from his nose to his tail, when standing in a natural position, is capable of carrying light field artillery, and the 12-pounder mountain howitzer, which, with its side arms, weighs from 330 to 350 lbs. The bed or carriage is carried by a second, and the ammunition by a third Camel.

From his size too he carries with ease large articles, such as long poles, planks, &c., and would be admirably adapted for the conveyance of Colonel Blanshard's small pontoon bridge.—Vide Plate.

A Camel would carry with ease two pontoons, with their saddles fixed, with several small stores.

The calculation of one Camel for every pontoon would be ample for the carriage of the complete pontoon equipment.

Ten pontoons, with their superstructure complete, weigh about 26 cwt. This would therefore allow a sufficient number of spare Camels.

In rocky ground the Camel is apt to slip, and his fore feet then are frequently spread out right and left: when this is the case, he splits up inside the arms, and dies, or becomes useless.

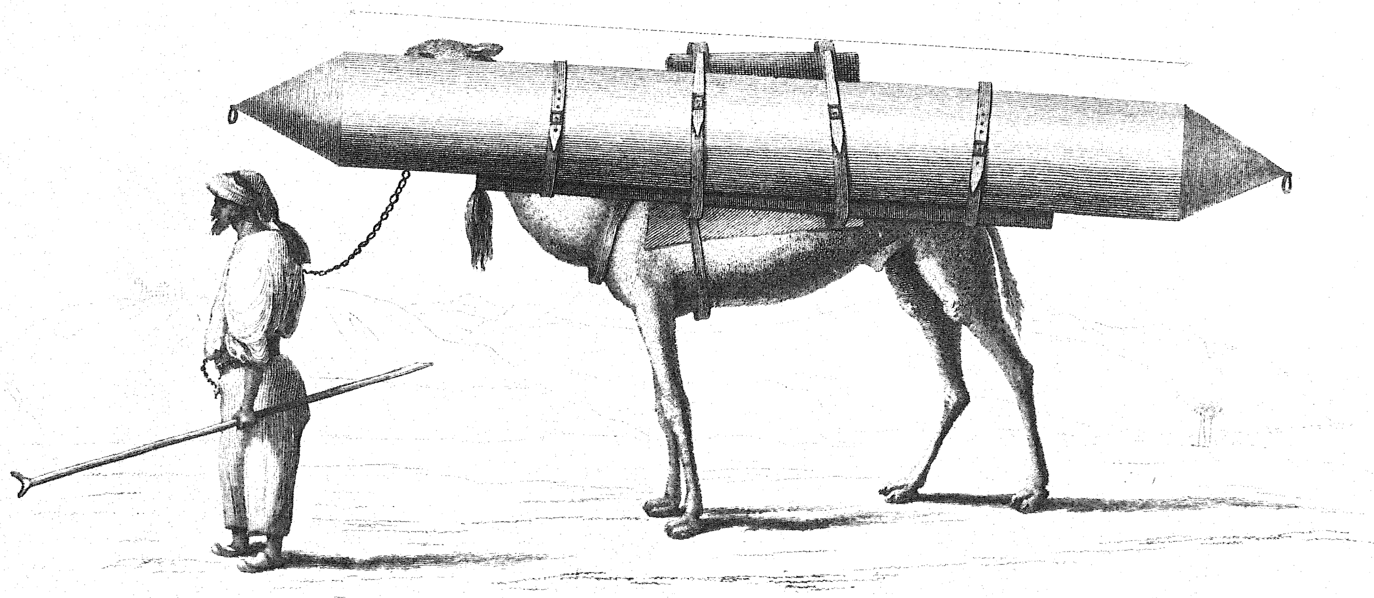
The Camel, though patient and obedient to his keeper, at whose command he lies down to be loaded, is frequently very savage with strangers, and his bite is very severe.

In Syria he is less valuable than the mule, and his price is from £10 to £15.

R. Alderson,
Lieut.-Colonel and Capt. R.E.

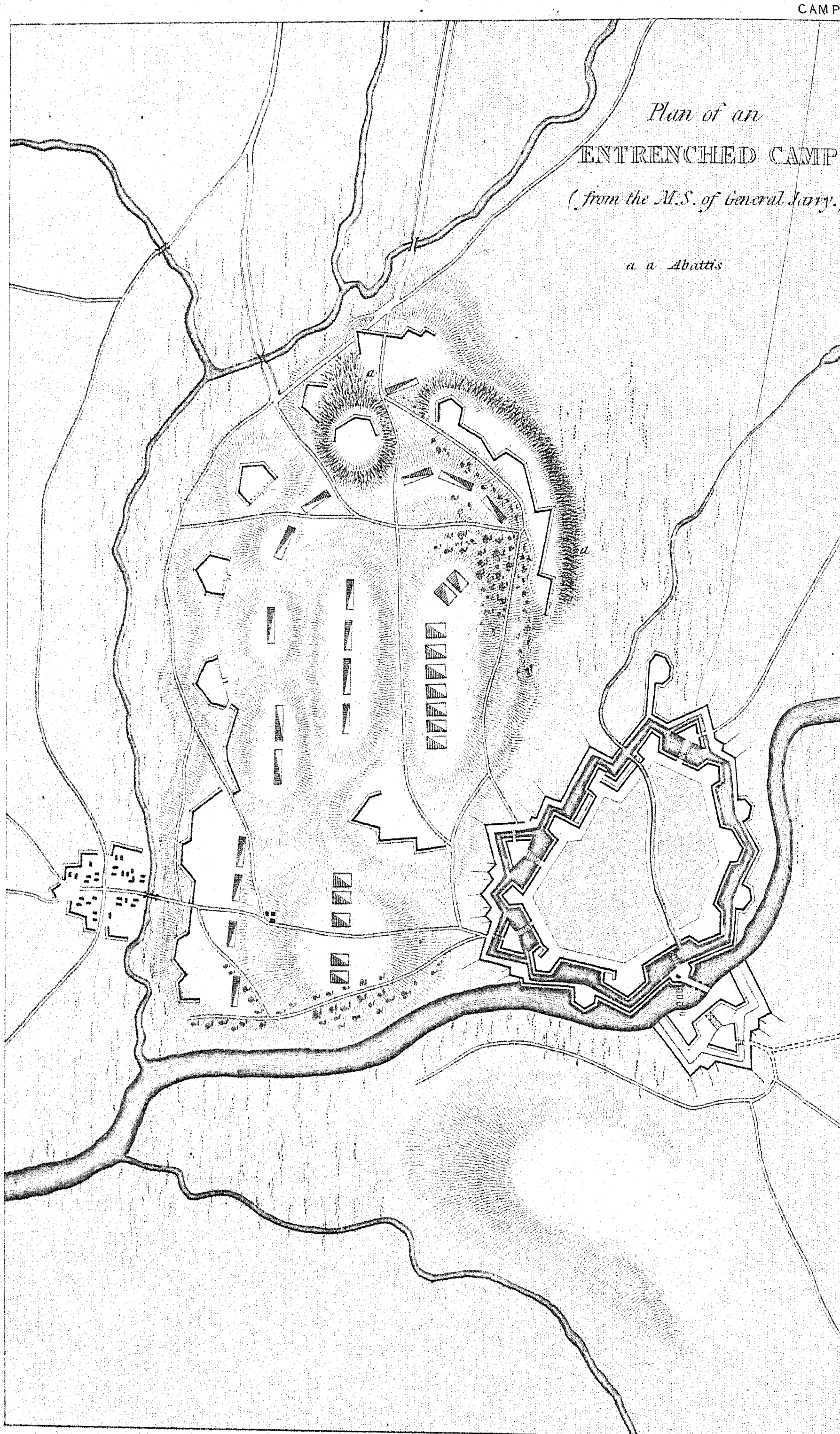
The Camel is still more liable to this 'splitting' (or rather dislocation of the shoulders) on slippery than on rocky ground; which is one reason why this animal cannot be generally used at the Cape: though usually hot and dry enough, yet, in the rains, no ground can be more slippery than the clay soils of that country.

In India also, the Camel stands high in the list of beasts of burthen, and is so employed by all departments—Artillery, Engineer, Commissariat, and Regimental. Its long-sustained powers under the saddle are well known. It is used in some instances for mounted Corps, and for the Rocket Service. In some parts the natives mount swivels on them, called 'zumbourouks,' or wasps.



A Syrian Camel with 2 of Colonel Blanchard's small Pontoons 12 ft long each without their Ends and 2 Saddles 8 ft 4 in long weighing altogether 2 cwt 1 qr 10 lb without the Packsaddle.

London, John Weale, 18[illegible].


Plan of an
ENTRENCHED CAMP
(from the M.S. of General Jarry.)
a a Abattis
a
a

The Camel is as peculiarly suited to the deserts as the mule is to the mountain,—or as the bullock to open countries without roads,—or as the horse, immeasurably and above all, to civilized countries with roads.

It is the judicious application of these useful animals that renders their services important and effective; failure results when their peculiarities are not consulted as to the country in which they are to be employed. In the late wars, however, no animal was found to have such a general suitability as the horse.

Memorandum.—The 'Camel' above mentioned is often called the Dromedary, being the one-humped variety, 'Camelus Dromedarius,' of Buffon and Cuvier. The two-humped, or 'C. Bactrianus,' is a larger and more powerful beast, better adapted to carry burthens, and to wet soils, but, with the Dromedary, quickly ruined by those of a stony character. On the deserts, the latter, under the saddle, will go from 10 to 12 miles per hour, without water, food, or intermission, for many hours together.

R. J. N.

CAMP, INTRENCHED.—The application of Intrenched Camps, as a strategetic question, is sufficiently explained in the 'Sketch of the Science and Art of War,' at the commencement of this volume.

An Intrenched Camp does not necessarily imply fortifying ground on which the troops are under canvass; but the general term comprehends fortifying a space or enclosure, whether the troops are encamped, bivouacked, or hutted: for the Distribution of the Troops, see 'Castrametation.'

As regards the works for Intrenched Camps, they are similar to those placed in fortifying a position, and taking advantage of natural obstacles, and resources found on the spot; but the Intrenched Camp is generally taken up for temporary purposes, whilst the fortified position is of a permanent nature, at least during hostilities.

Intrenched Camps are seldom constructed, in consequence of the immense labour; and when required, their use appears to be limited to the following objects:

1. For the security of an Army or Corps to cover a siege.
2. To Intrench a Corps of Observation for the security of a line of frontier or territory, whilst the main army is occupied with offensive operations in another direction.
3. For the defence of a frontier; placed in conjunction, or immediate connection, with a fortified place.

Vauban attached great importance to this last proposition of constructing Intrenched Camps; and he considered that one or two positions thus taken up by a force in an unattackable site, except by a regular siege, would enable an inferior army between them to contend against an enemy greatly superior.—Vide Plate of an Intrenched Camp.

The following rules are generally adopted in the selection of ground for an Intrenched Camp.

1. The site, supposes an advantageous ground to which it is only necessary to add some artificial assistance. The fortifications are disposed as if they were the enceinte of a place, of which the bastions, or works, are detached and closed by the gorge, to form so many separate forts. Curtains, if used, may be added, but not joined to the bastions, in order to leave sufficient passages for the troops. One of the principal considerations in the choice of a site, is having sufficient depth for the formation of the troops; and the ground should not be open to a cannonade from the neighbouring heights;—and all villages within 1500 yards should be occupied, and all obstructions removed within that distance.

2. An inaccessible position is not always taken up, without it can be easily succoured, if necessary; as an Intrenched Camp seldom has all the resources for a long defence, and the means of retreat should be considered.

3. The junction of two rivers frequently offers an advantageous site for an Intrenched Camp; particularly in connection with a fortified place, as such a position is difficult to blockade, and easily succoured.

4. An ample supply of stores, ammunition, food, fuel, forage, and water, is necessary to meet the object of occupying the fortified Camp; for without these, the expense and labour are thrown away.

The detail of construction will be found under the head of 'Field Fortification,' and their application is further exemplified in the 'Defence of Posts, Villages, and Open Towns;' for an Intrenched Camp is a judicious combination of these resources, taking advantage, as before observed, of natural obstacles, such as inundation, marshes, bog, or precipitous ground.

G. G. L.

CAPONIÈRE.—This description of defence, when intended to be occupied, is only suited to permanent Field Fortification, on account of the great relief necessary to receive it, and the labour and expense attendant, if on a footing likely to be efficient.

Fig. 3, Plate I., shews the lowest section that can be given in this case; and even then the principle of having the loopholes 8 feet, at least, above the ground, has been sacrificed to reduce the height of the rampart as much as possible. It is not, however, requisite that the whole work should have the dimensions of figs. 1, 2, near the salient: taking advantage of the extra height to establish a cavalier, the parapet may soon drop to an ordinary section, as at A: much of the earth from the ditch in the neighbourhood of that point will be required for the completion of the salient and its glacis.

Such a Caponière becomes a complete wooden house (shewn in plan by *e*, *f*, *b′*, *c′*, fig. 1, Plate I.), built on the level of the bottom of the ditch, being let into the escarp and counterscarp at the ends, and communicating with the work by a gallery.

With reference to fig. 3, Plate I., it is presumed to be proof against musketry and splinters of howitzer shells, though not against the shells themselves, any more than the sides of a ship are proof against shot. The loopholes are only 5 feet 8 inches above the ground, instead of 8 feet, as above explained, but they may be protected by abattis to such extent as will not mask their fire—ditches in front being objectionable as accumulating stagnant water.* Sufficient width is given to admit of two opposite ranks loading and handing the muskets to the men on the banquettes. Spaces, *e*, *e*, fig. 4, are left on each side of the tie-beams for ventilation; they and the loopholes can be fitted with small sliding sashes.

Eighteen or twenty men can sleep on the banquettes, lengthwise; in extreme cases, treble that number will find shelter, if placed also on camp trestles and boards on the ground, to be packed up and put away under the banquette when not wanted as beds or tables. Every precaution must be taken to preserve these Caponières dry, if to be thus inhabited: the ends of the building should be kept from touching the earth by means of dry rubble; the bottom of the ditch sloped so as to carry off rain or spring water; the walls well caulked with moss, oakum, flax or hemp combings, or the in-

* Except in case of a gravelly soil, through which water will pass freely; in clay or loam it will stagnate; sand ditches will not preserve their dimensions; and sinking in rock for a field-work can hardly be required.

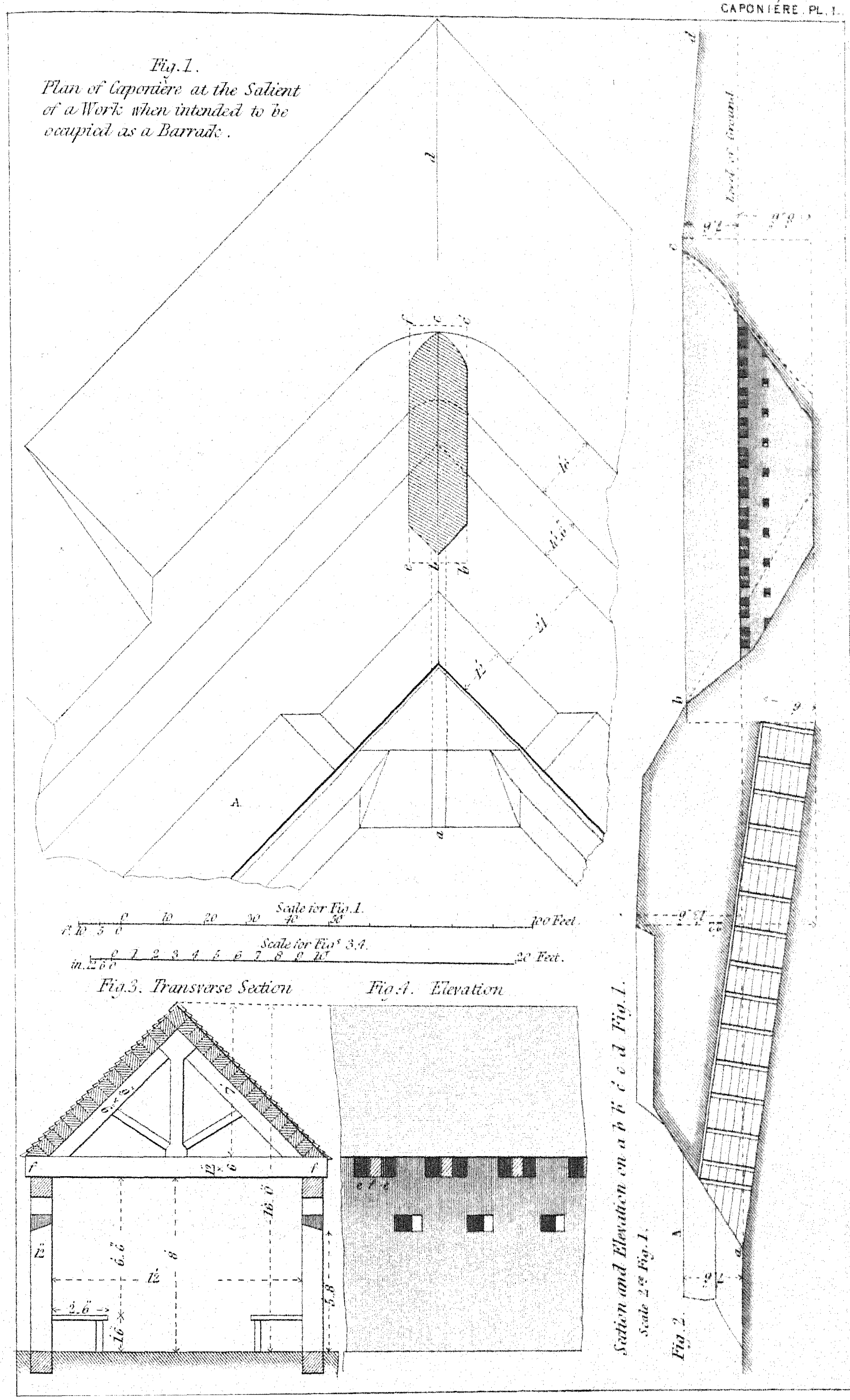
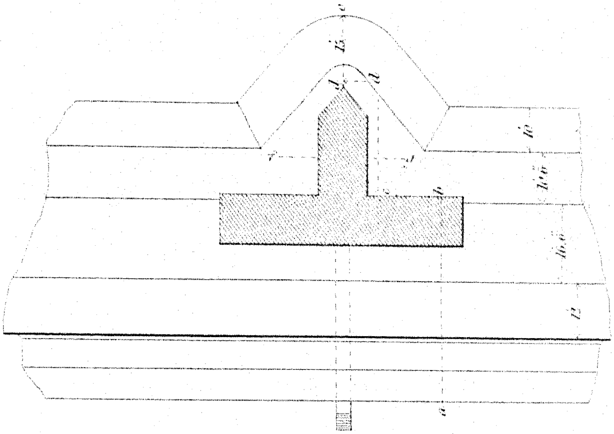


Fig. 1.
Plan of Caponière at the Salient of a Work when intended to be occupied as a Barrack.
Scale for Fig. 1.
100 Feet.
Scale for Figs 3. 4.
20 Feet.
Fig. 3. Transverse Section
Fig. 4. Elevation
Level of Ground
Section and Elevation on a b b' c' c d Fig. 1.
Scale 2ce Fig. 1.
Fig. 2.

Fig. 1.

Plan of a Caponière on the Face of a Work when not intended to be occupied as a Barrack.



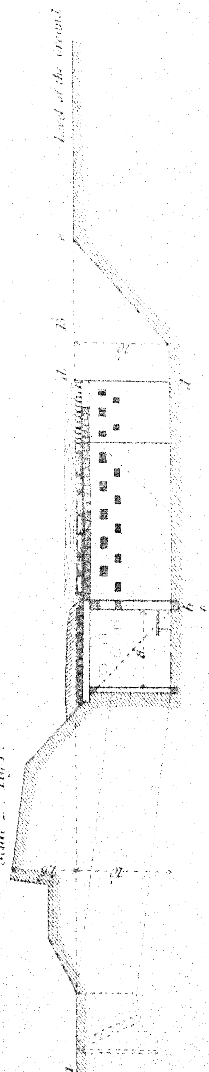


Fig. 2. Section & Elevation on a.b, c.d, d.e, Fig. 1.
Scale 2ce Fig. 1.

Fig. 3.
Transverse Section on f.g.

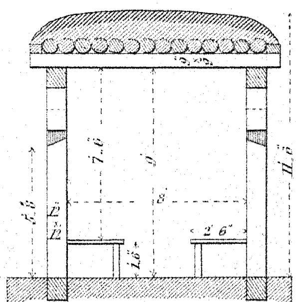
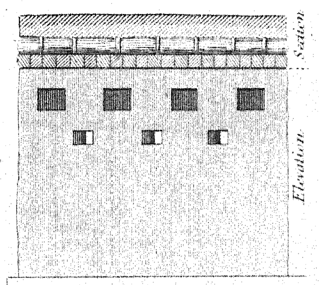


Fig. 4.
Elevation on c.d.



Scale for Fig. 1.

Scale for Figs. 3. 4.

side bark of most trees,—this caulking followed up as the wood-work shrinks; and the floor of well-rammed clay, finished on top with dry gravel: and the whole may be weather-boarded outside.

In fig. 3, Plate I., the walls are given as of solid upright baulks, between a capsill and groundsill; they may, however, be laid horizontally, as shewn in 'Blockhouse,' Plates I. II.; or, if no baulk can be obtained, the thickness of 12 inches may be made good by courses of plank crossing each other, which gives stability, and a more comfortable dwelling, as being less liable to the annoyances occasioned by the shrinking of the timber.

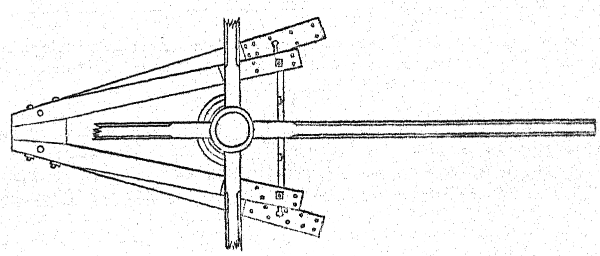
If to avoid the objection of raising the work to such a height, the Caponière be sunk, so that the loopholes are nearly flush with the ground, there will still be 11 feet left above that level: it cannot be used conveniently as a barrack; and the defenders will be liable to being taken in reverse through the openings left for ventilation.

When *not* intended to be occupied, such a section as fig. 3, Plate II., will be advisable: the roof is sufficiently weather and splinter-proof; and a less width in the interior is necessary. It is not recommended to sink a Caponière on any account; ditches being objectionable, the defenders are, as above, liable to be fired on through the ventilators, and, being thus cooped up, and annoyed with smoke, are worse off than the assailants: without ventilation, these works are untenable. A less width or height than 8 feet is very objectionable.

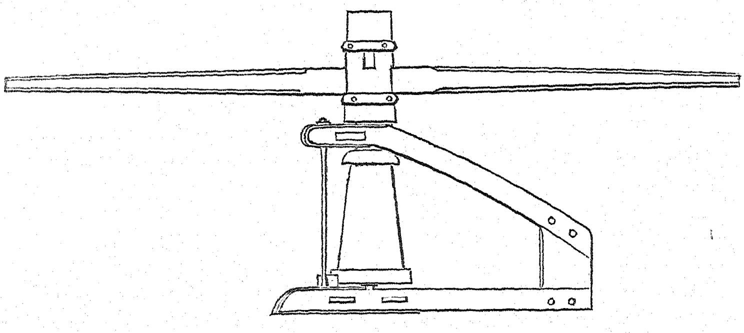
In Plate I. fig. 1, the Caponière having abutments at both ends, the structure will be necessarily stable; but in Plate II. fig. 1, the outer end has not this advantage. The inside of the walls and the roof, therefore, must be well braced with diagonal battens. It is also to be observed, that no extra height of parapet or rampart is absolutely necessary in Plate II. The ditch is made wider there than may be requisite in other parts of the work, so as to give a respectable flanking defence; and if command is necessary for the parapet, the ditch may be shallower, but then the requisite cover for the Caponière must be given by a small glacis, as in fig. 1, Plate I.

A Caponière may be used as a bridge: the section in fig. 3, Plate II., is quite adapted to this purpose. R. J. N.

CAPSTAN, FIELD.—The following wood-cut gives a simple and very effective Capstan, that is easily made. As there is no wheel-work or other provision for multiplying power, this last is to be supplied by main force, presumed to be generally and abundantly available when such contrivances are required. In connection with blocks and tacles, it is applicable to straining the tension gear of rope bridges, as well as to many other engineer purposes; and can be used with sheers in embarking and disembarking artillery, &c.



It is sometimes, but improperly, called the Crab Capstan.



CARCASS.—*Vide* 'LABORATORY.'

CARRIAGE, GUN AND BATTERY.

MEMORANDA ON PRINCIPLES OF CONSTRUCTION.

The rules by which Guns and Carriages are constructed in the British Service, have been obtained rather by practice and experiment, than by any symmetrically arranged and general theory: the consequence is, that even the considerable approach that has been thus far made towards perfection and simplicity of system, still leaves room for improvement which would not, possibly, have been necessary, had the 'Systematic' been as much attended to as in the French Service,* and so great a preference not been given to the 'Experimental.'

Of the two extremes, the latter, judging from the excellence of its results, is undoubtedly preferable; and the experience gained during the late wars has, perhaps, left little of very serious import as yet unexecuted. The extent, however, to which our *accidental* system has been carried, is now so great as to render alteration, to any great amount, well-nigh impracticable. We have at this moment upwards of fifty authorized descriptions of Ordnance, and in but few instances can the Gun Carriage of different sorts of pieces be replaced by those of another kind in case of accidents.

Hence, few principles of construction can be offered; and it is conceived that the best mode of supplying their place, is to give such a series of Plates as is now attached to these remarks, letting the figures speak for themselves. Every possible

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* Affûts et Voitures.—Il y a deux affûts de campagne: l'un, pour le canon de 12, et l'obusier de 6°, est destiné aux batteries de réserve, et à l'armement des places; l'autre, pour le canon de 8, et l'obusier de 24, est destiné aux batteries des divisions d'infanterie et de cavalerie.

Un seul affût de montagne; celui de l'obusier de 12.

Deux affûts de siége, l'un pour le canon de 24, et pour l'obusier de 8°; et l'autre, pour le canon de 16. Ces deux affûts, portent leur bouche à feu en route. Trois affûts de place et côte: le premier, commun aux canons de 24 en bronze, et de 18 et 16 en fer; le troisième particulier aux canons de 12 en bronze. Trois affûts de mortiers: No. 1, pour mortier ancien modèle de 12° et 10° à grande portée, et pour mortier de 10° à la Gomer: No. 2, pour mortier de 10° à petite portée et pierrier: No. 3, pour mortier de 8° ancien modèle, et de 8° à la Gomer.—*Aide-Mémoire portatif à l'usage des Officiers du Génie. Par Laisné.* Ed. 2, p. 149.

pains has been taken to insure accuracy in such as have been executed in Dublin; and with regard to those obtained from other quarters, acknowledgment is chiefly due to Captain Gore, R.A.; though it is not to be understood, or expected, that he can be individually responsible for the performances of the draftsmen working under his *general* superintendence.

Nevertheless, to meet possible error in the drawings, either in original or copy, Tables I—XIV. have been expressly obtained (from authority), to supply with sufficient accuracy information likely to concern the Royal Engineer Department; and in these Tables, it is to be observed, that convenience of reference has been consulted rather than condensation of matter.

Although, with reference to the above remarks, a preference to the 'Experimental' has been so considerable, still much has been done to obtain the advantages of Systematic Classification, with regard to the following principles,—viz.:

The Identical—as when the wheel of a 6-pounder may be replaced by that of a 9-pounder.

The Homogeneous—as when the same Traversing Platform serves for different sorts of Guns.

The Homologous—as when the 24-pounder Garrison Carriage corresponds in form with that for the 12-pounder, but not in dimensions; although no replacement, or exchange of duty, can therefore occur.

THE IDENTICAL.

To secure this for each description, individually, all Carriages are built by pattern and fixed dimensions; so that, for instance, any one part of a 9-pounder Carriage may be replaced by its correspondent in any other 9-pounder Carriage.

There is but one *Carriage* for ammunition waggons, from that of the 24-pounder iron Gun to the heavy brass 3-pounder, and even to the 6-pounder and 12-pounder Rockets. There are only variations in the dimensions of the boxes, depending on the nature and bulk of the ammunition.

The same Limber applies to the four following: the 24-pounder and 18-pounder iron Guns, and the 10-inch and 8-inch Howitzers.

The 24-pounder and 12-pounder Howitzer have the 6-pounder Limber.

The diameter of 5 feet is given to *all* wheels from the 32-pounder Howitzer and 12-pounder Gun, down to the heavy 3-pounder and 12 and 6-pounder Rockets, inclusive; the tire of the Gun or Howitzer Carriage wheel being ¼th of an inch wider than that of the Limber or other Carriages attached to it.

N.B.—To carry out the system of replacement thoroughly, would probably require a serious change in the construction of Guns; thus with reference to Garrison Carriages only, by Artillery Tables A. B., and Artillery Plate I. fig. 1, the diameter (F) between the shoulders is in different guns of the same calibre,

″	″	″
32-pr.—17·72	24-pr.—16·88	18-pr.—15·8
16·82	16·8	14·15
16·48	14·5	
16·45		
15·6		

And to apply this consistently throughout, would be, probably, to introduce a new *principle* in the construction of Ordnance; viz., that all pieces of which the Carriages are intended to replace one another, must have the same width at the

trunnions, whether light or heavy, or whether long or short; particularly in those of iron.

THE HOMOGENEOUS.

The same height will in future be given to all Garrison Carriages, to enable them to fire over a 2-feet 3-inch genouillère at a depression of 2° with the common quoin.

The same length of axle is given to the new pattern 18, 24, and 32-pounder Garrison Carriages, to enable them to suit the iron Traversing Platform.

Hence, the height of Carriage and length of axle-tree being fixed, the above three can only vary in length and breadth, and they will therefore be all dissimilar *in proportions*. Here, the inferior principle of symmetrical arrangement has been superseded by one of greater practical importance; so that all should be available in all batteries (barbette or embrasure), having the usual height of genouillère. Where Traversing Platforms are used, any adjustments required can be given on the height of the curb.

THE HOMOLOGOUS.

This is chiefly the result of like causes producing like results; by which, Guns of the same character are likely to be mounted in a similar manner:

Thus, the 32, 24, 18, &c., for Garrisons, having like duties, under like circumstances, their Carriages all resemble one another.

But the 24, 18, and 12-pounders alone have Bracket Carriages, being the only guns that have been fitted for Siege or Position Batteries; and their Carriages are (with exception of the uniform height of wheel) 'similar solids.'

The 32-pounder and 12-pounder Carriage are much alike in form and dimension; but are not adapted to exchange.

The 24-pounder and 12-pounder Howitzer Carriage, and those for 9, 6, and heavy 3-pounders, are, in their respective groups, similar solids; but in no one instance, except the wheels, can they, in whole or part, replace each other.

The value of this third, last, and least important principle, lies, perhaps, in its connection with order and uniformity, and the tendency of these last to check unnecessary innovation.

In concluding these remarks on Principles of Construction, one instance may be quoted in which the symmetrical plan receives a peculiar check from expediency itself, *i.e.* in the balance of Guns on Field Carriages,—a different poise being advisable when limbered up for Travelling, from that required when unlimbered for Action. This difficulty has been met by compromise in the 9-pounder Field Gun, and downwards, by one set of trunnion boxes being made to suffice, and so regulated that the centre of the trunnion shall be about $\frac{1}{4}$ inch behind that of the axle-tree when unlimbered: but in the 32-pounder Howitzer, the 12-pounder Gun (brass), and the Siege Guns, they have travelling as well as fighting trunnion boxes;—an arrangement which, again, does not appear in the 10 and 8-inch iron, and the 24-pounder and 12-pounder brass Howitzers, probably owing to the compactness of their forms.

MATERIALS, &c.

There has been no change of any importance, lately, in this respect, except in the adoption of oak instead of elm for the brackets; and also of oak for the axle-tree beds in lieu of ash: thus the whole Field Gun or Howitzer Carriage is now of oak, except in the wheels, of which the spokes, nave, and felloes remain of oak, elm, and ash, respectively, as before; and in the boxes, &c., which are partly of elm and partly of deal, as hitherto.

The wooden Garrison Carriages are of oak, from its durability; but the cheeks of Ship Carriages are of elm, as they are not generally so exposed to the weather, and because the latter wood is less liable to splinter than the former. Oak is kept three years and elm two, to season, after having been reduced to plank.*

Cast Iron Carriages undergo proof, first by the hammer, and then by 1 in every 10 standing 3 rounds with service-charge, 2 shot, and 1 wad. The fate of the whole set depends on the way in which those thus selected stand the trial.

REMARKS ON THE PLATES AND TABLES.

The wheels are invariably represented upright, to avoid the trouble of projecting them as ellipses: the true distances between them are given therefore in the Tables.

These drawings were mostly from actual measurement; hence the wheels will seldom be found to have precisely their normal dimensions. There will probably be a difference of 2 inches between the diameter of a new wheel, and that which it will have after long seasoning, and two thorough repairs. The present mode of fixing the tire by nut and screw is shewn in Plate VIII.

Depression Carriages do not appear in the series; there has been some delay in obtaining drawings of them from stations where they are used: it is hoped that they will appear in Part II.

Neither is the Mortar 'Platform' Waggon given; a substitute for this being to be had in the Sling Waggon, Sling Cart, or Devil Carriage.

The 13-inch Mortar and its bed are always carried on separate Carriages, but may be considered as in disuse in the attack of places.

The 10-inch, on a Devil Carriage, mounted on its bed, the quoin taken out; or a Platform Waggon, the bed over the hind axle-tree, the mortar over the fore axle-tree, muzzle to the front. This mortar may also be carried in one trench cart, and its bed in another.

The 8-inch Mortar, mounted on its bed, quoin out, muzzle inwards. A trench cart carries one mortar complete.

The two last columns in Tables I.—XIV. have been computed partly from the data in the other columns, and partly from the known weight of guns, stores, of the proper number of horses, and the probable number of men accompanying each carriage as it passes over a bridge: it is to shew the strain thus brought on bridges, that these two columns have been added; only it should be borne in mind, that all calculations in such cases must refer to *moving*, and not *dead* weights.

The 'Length on line of march' includes the length of one horse as the regulation distance between two successive carriages.

The length given in the 4th column is that of each carriage when limbered up, but without the horses.

R. J. N.

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* It does not appear that teak wood has ever been used in the British Service for Gun Carriages, to which, however, it is conceived to be particularly suited; it is cheaper, lighter, stronger, and as durable: the weight of the Malabar teak is upwards of 50 lbs. per cubic foot; and in regard to strength, the value of S is 2239. The sap, which in oak is so destructive to iron, is highly conservative of it in teak. Lastly, this wood requires little or no seasoning, whilst, as above stated, oak requires three years.—*Editors.*

TABLE I.—24-pounder Siege Gun.

	Weight.	Bulk as for tonnage.	Total length as placed in a gun shed.	Length of axle or extreme breadth of carriage.	Distance between fore and hind axles.	Breadth between wheels at the tires. Above.	Breadth between wheels at the tires. Below.	Breadth of tire.	Diameter of wheel.	Gross weight.	Total length on line of march.
	cwt. qr. lbs.	ft.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	cwt.	ft.
Gun carriage . . .	23 3 25¾	239	23 9	6 7¼	9 7¾	4 10½	4 6½	5	5 0	179	61
,, limber . . .	7 1 27½			6 2½		4 10½	4 6	3¼	3 10		
Pair of wheels, fore .	3 2 10	40	,,	,,	,,	,,	,,	3¼	3 10	,,	,,
,, hind	8 1 12	90	,,	,,	,,	,,	,,	5	5 0	,,	,,
Axles, fore . . .	1 0 6	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
,, hind . . .	1 3 2½	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,

TABLE II.—18-pounder Iron Gun.

	Weight.	Bulk as for tonnage.	Total length as placed in a gun shed.	Length of axle or extreme breadth of carriage.	Distance between fore and hind axles.	Breadth between wheels at the tires. Above.	Breadth between wheels at the tires. Below.	Breadth of tire.	Diameter of wheel.	Gross weight.	Total length on line of march.
	cwt. qr. lbs.	ft.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	cwt.	ft.
Gun carriage . . .	18 1 26¾	199	21 6	6 4¾	8 2½	4 11	4 6	4	5 0	162	59
,, limber . . .	7 1 27½			6 2½		4 10½	4 6	3¼	3 10		
Ammunition waggon	10 3 24	240	,,	6 3	7 7¾	5 5	4 9	2½	5 0	115	48
,, limber.	8 2 10¼			6 3		5 5	4 9	2½	5 0		
Pair of wheels, fore .	3 2 10	40	,,	,,	,,	,,	,,	,,	3 10	,,	,,
,, hind	7 0 0	65	,,	,,	,,	,,	,,	,,	5 0	,,	,,
Axles, fore . . .	1 0 6	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
,, hind . . .	1 1 18	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,

TABLE III.—12-POUNDER MEDIUM GUN.

	Weight.			Bulk as for tonnage.	Total length as placed in a gun shed.		Length of axle or extreme breadth of carriage.		Distance between fore and hind axles.		Breadth between wheels at the tires. Above.		Below.		Breadth of tire.	Diameter of wheel.		Total weight.	Total length on line of march.
	cwt.	qr.	lbs.	cub. ft.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	in.	ft.	in.	cwt.	ft.
Gun carriage . . .	12	2	8	234	23	9	6	5	9	9½	5	5½	4	9	2¾	5	0	140	61
„ limber . . .	9	2	2				6	5			5	5½	4	9	2¾				
Ammunition waggon	10	3	9	240	20	4	6	3	7	7¾	5	5	4	9	2½	5	0	114	48
„ limber.	8	2	7																
Spare wheel carriage & sp. wheels	17	3	0	280	Ditto as gun carriage and limber.													82	52
„ limber.	8	2	11																
Store limber carriage	10	3	7	227	20	7	6	3	7	8	5	5	4	9	2½	5	0	74	48
„ limber.	8	0	10																
Forge waggon . .	9	2	26	239	20	8	6	3	7	1½	5	5	4	9	2½	5	0	74	48
„ limber.	8	0	10																
Baggage cart . . .	9	0	8	104	12	8	6	3	„		5	5	4	9	2½	5	0	48	23
Pair of wheels, light	3	2	20	43	„		„		„		„		„		2½	5	0	„	„
„ heavy	4	1	8	47	„		„		„		„		„		2¾	5	0	„	„
Axle	1	0	2	„	„		„		„		„		„		„	„		„	„

TABLE IV.—9-POUNDER GUN.

	Weight.			Bulk as for tonnage.	Total length as placed in a gun shed.		Length of axle or extreme breadth of carriage.		Distance between fore and hind axles.		Breadth between wheels at the tires. Above.		Below.		Breadth of tire.	Diameter of wheel.		Total weight.	Total length on line of march.
	cwt.	qr.	lbs.	cub. ft.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	in.	ft.	in.	cwt.	ft.
Gun carriage . . .	12	0	19	201	22	7¼	6	5	9	2	5	5½	4	9	2¾	5	0	134	61
„ limber . . .	8	1	24				6	3			5	5	4	9	2½	5	0		
Ammunition waggon	10	3	11	238	20	4	6	3	7	7¾	5	5	4	9	2½	5	0	113	48
„ limber.	8	1	24																
Spare wheel carriage & sp. wheels	16	3	8	248	Ditto as gun carriage and limber.													81	51
„ limber.	7	3	11																
Store limber carriage	10	3	7	227	20	7	6	3	7	8	5	5	4	9	2½	5	0	74	48
„ limber .	8	0	10																
Forge waggon . .	9	2	26	239	20	8	6	3	7	1½	5	5	4	9	2½	5	0	74	48
„ limber . . .	8	0	10																
Baggage cart . . .	9	0	8	104	12	8	6	3	„		5	5	4	9	2½	5	0	48	23
Pair of wheels, light .	3	2	20	43	„		„		„		„		„		2½	5	0	„	„
„ heavy	4	1	8	47	„		„		„		„		„		2¾	5	0	„	„
Axle, light	0	3	12	„	„		„		„		„		„		„	„		„	„
„ heavy . . .	1	0	2	„	„		„		„		„		„		„	„		„	„

TABLE V.—HEAVY 6-POUNDER GUN.

	Weight.			Bulk as for tonnage.	Total length as placed in a gun shed.		Length of axle or extreme breadth of carriage.		Distance between fore and hind axles.		Breadth between wheels at the tires.				Breadth of tire.	Diameter of wheel.		Total weight.	Total length on line of march.
											Above.		Below.						
	cwt.	qr.	lbs.	cub. ft.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	in.	ft.	in.	cwt.	ft.
Gun carriage . . .	11	0	10	202	23	5¾	6	5	9	5¼	5	5½	4	9	2¾	5	0	132	60
,, limber . . .	8	1	26				6	3			5	5	4	9	2½	5	0		
Ammunition waggon	10	3	4	238	20	4	6	3	7	7¾	5	5	4	9	2½	5	0	113	48
,, limber .	8	1	26																
Spare wheel carriage & sp. wheels	15	3	22	249	Ditto as gun carriage and limber.													80	50
,, limber .	7	3	11																
Store limber carriage	10	3	7	227	20	7	6	3	7	8	5	5	4	9	2½	5	0	74	48
,, limber .	8	0	10																
Forge waggon . .	9	2	26	239	20	8	6	3	7	1½	5	5	4	9	2½	5	0	74	48
,, limber . . .	8	0	10																
Baggage cart . . .	9	0	8	104	12	8	6	3	,,		5	5	4	9	2½	5	0	48	23
Pair of wheels, light .	3	2	20	43	,,		,,		,,		,,		,,		2½	5	0	,,	,,
,, heavy	4	1	8	47	,,		,,		,,		,,		,,		2¾	5	0	,,	,,
Axle, light . . .	0	3	12	,,	,,		,,		,,		,,		,,		,,	,,		,,	,,
,, heavy . . .	1	0	2	,,	,,		,,		,,		,,		,,		,,	,,		,,	,,

TABLE VI.—LIGHT 6-POUNDER GUN.

	Weight.			Bulk as for tonnage.	Total length as placed in a gun shed.		Length of axle or extreme breadth of carriage.		Distance between fore and hind axles.		Breadth between wheels at the tires.				Breadth of tire.	Diameter of wheel.		Total weight.	Total length on line of march.
											Above.		Below.						
	cwt.	qr.	lbs.	cub. ft.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	in.	ft.	in.	cwt.	ft.
Gun carriage . . .	9	1	15	182	21	10	6	3	8	9½	5	5	4	9	2½	5	0	104	59
,, limber . . .	8	1	18																
Ammunition waggon	10	3	4	235	20	3½	6	3	7	7¾	5	5	4	9	2½	5	0	112	48
,, limber .	8	1	18																
Spare wheel carriage & sp. wheels	13	0	31	225	Ditto as gun carriage and limber.													79	50
,, limber .	7	3	11																
Store limber carriage	10	3	7	227	20	7	6	3	7	8	5	5	4	9	2½	5	0	74	48
,, limber .	8	0	10																
Forge waggon . .	9	2	26	239	20	8	6	3	7	1½	5	5	4	9	2½	5	0	74	48
,, limber .	8	0	10																
Baggage cart . . .	9	0	8	104	12	8	6	3	,,		5	5	4	9	2½	5	0	48	23
Pair of wheels . .	3	2	20	43	,,		,,		,,		,,		,,		2½	5	0	,,	,,
Axle	0	3	12	,,	,,		,,		,,		,,		,,		,,	,,		,,	,,

TABLE VII.—LIGHT 3-POUNDER GUN.

	Weight.			Bulk as for tonnage.	Total length as placed in a gun shed.		Length of axle or extreme breadth of carriage.		Distance between fore and hind axles.		Breadth between wheels at the tires. Above.		Below.		Breadth of tire.	Diameter of wheel.		Total weight.	Total length on line of march.
	cwt.	qr.	lbs.	cub. ft.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	in.	ft.	in.	cwt.	ft.
Gun carriage . . .	4	1	9	90	16	6	4	8	6	7¼	3	11	3	7½	2¼	4	4	97	44
„ limber . . .	3	3	4																
Limber car . . .	3	3	16	51	9	4	4	8	„		3	11	3	7½	2¼	4	4	62	28
Pair of wheels . .	2	1	0	28	„		„		„		„		„		2¼	4	4	„	„
Axle	0	1	10	„	„		„		„		„		„		„	„		„	„

TABLE VIII.—3-POUNDER MOUNTAIN GUN.

	Weight.			Bulk as for tonnage.	Total length as placed in a gun shed.		Length of axle or extreme breadth of carriage.		Distance between fore and hind axles.		Breadth between wheels at the tires. Above.		Below.		Breadth of tire.	Diameter of wheel.		Total weight.	Total length on line of march.
	cwt.	qr.	lbs.	cub. ft.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	in.	ft.	in.	cwt.	ft.
Gun carriage . . .	1	3	17	23	12	1	3	1½	„		2	3¼	2	3¼	1¾	3	0	24	22
Shafts	0	1	17																
Boxes, large . . .	1	0	8	18	„		„		„		„		„		„	„		„	„
„ small . . .	0	2	11																
Pair of wheels . .	0	3	22	11	„		„		„		„		„		1¾	3	0	„	„
Axle	0	0	20½	„	„		„		„		„		„		„	„		„	„

TABLE IX.—10-INCH IRON HOWITZER.

	Weight.			Bulk as for tonnage.	Total length as placed in a gun shed.		Length of axle or extreme breadth of carriage.		Distance between fore and hind axles.		Breadth between wheels at the tires. Above.		Below.		Breadth of tire.	Diameter of wheel.		Total weight.	Total length on line of march.
	cwt.	qr.	lbs.	cub. ft.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	in.	ft.	in.	cwt.	ft.
Howitzer carriage . .	31	2	10	258	23	0	6	7¼	9	9½	4	10½	4	6½	5	5	0	180	60
„ limber . .	7	2	0				6	2½			4	10½	4	6	3¼	3	10		
Pair of wheels, fore .	3	2	10	29	„		„		„		„		„		3¼	3	10	„	„
„ hind .	8	1	12	63	„		„		„		„		„		5	5	0	„	„
Axle, fore	1	0	6	„	„		„		„		„		„		„	„		„	„
„ hind . . .	1	3	3	„	„		„		„		„		„		„	„		„	„

TABLE X.—8-inch Iron Howitzer.

	Weight.	Bulk as for tonnage.	Total length as placed in a gun shed.	Length of axle or extreme breadth of carriage.	Distance between fore and hind axles.	Breadth between wheels at the tires. Above.	Breadth between wheels at the tires. Below.	Breadth of tire.	Diameter of wheel.	Total weight.	Total length on line of march.
	cwt. qr. lbs.	cub. ft.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	cwt.	ft.
Howitzer carriage .	24 1 14	238	21 5	6 4¾	9 0	4 11	4 6	4	5 0	154	59
,, limber. .	7 2 0			6 2½		4 10½	4 6	3¼	3 10		
Ammunition waggon	11 0 0	239	20 4	6 3	7 7¾	5 5	4 9	2½	5 0	116	48
,, limber.	8 2 20										
Pair of wheels, fore .	3 2 10	29	,,	,,	,,	,,	,,	3¼	3 10	,,	,,
,, hind.	7 0 0	55	,,	,,	,,	,,	,,	4	5 0	,,	,,
Axle, fore	1 0 6	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
,, hind . . .	1 1 18	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,

TABLE XI.—32-pounder Brass Howitzer.

	Weight.	Bulk as for tonnage.	Total length as placed in a gun shed.	Length of axle or extreme breadth of carriage.	Distance between fore and hind axles.	Breadth between wheels at the tires. Above.	Breadth between wheels at the tires. Below.	Breadth of tire.	Diameter of wheel.	Total weight.	Total length on line of march.
	cwt. qr. lbs.	cub. ft.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	cwt.	ft.
Howitzer carriage .	12 2 19	230	23 0	6 5	9 9½	5 5½	4 9	2¾	5 0	140	60
,, limber. .	9 3 0										
Ammunition waggon	10 3 1	240	20 4	6 3	7 7¾	5 5	4 9	2½	5 0	115	48
,, limber.	8 2 11										
Pair of wheels . .	4 1 8	47	,,	,,	,,	,,	,,	2¾	5 0	,,	,,
Axle	1 0 2	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,

TABLE XII.—24-pounder Brass Howitzer.

	Weight.	Bulk as for tonnage.	Total length as placed in a gun shed.	Length of axle or extreme breadth of carriage.	Distance between fore and hind axles.	Breadth between wheels at the tires. Above.	Breadth between wheels at the tires. Below.	Breadth of tire.	Diameter of wheel.	Total weight.	Total length on line of march.
	cwt. qr. lbs.	cub. ft.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	cwt.	ft.
Howitzer carriage .	12 2 13	207	21 8	6 5	8 10½	5 5½	4 9	2¾	5 0	134	59
,, limber. .	8 2 5			6 3		5 5	4 9	2½	5 0		
Ammunition waggon	10 3 5	238	20 4	6 3	7 7¾	5 5	4 9	2½	5 0	114	48
,, limber.	8 2 5										
Pair of wheels, light .	3 2 20	43	,,	,,	,,	,,	,,	2½	5 0	,,	,,
heavy	4 1 8	47	,,	,,	,,	,,	,,	2¾	5 0	,,	,,
Axle, light . . .	0 3 12	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
,, heavy . . .	1 0 2	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,

TABLE XIII.—12-pounder Brass Howitzer.

	Weight.	Bulk as for tonnage.	Total length as placed in a gun shed.	Length of axle or extreme breadth of carriage.	Distance between fore and hind axle.	Breadth between wheels at the tires. Above.	Below.	Breadth of tire.	Diameter of wheel.	Total weight.	Total length on line of march.
	cwt. qr. lbs.	cub. ft.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	cwt.	ft.
Howitzer carriage	10 0 13	182	21 2	6 3	8 $10\frac{3}{4}$	5 5	4 9	$2\frac{1}{2}$	5 0	125	58
" limber	8 2 0										
Ammunition waggon	10 3 14	237	20 4	6 3	7 $7\frac{3}{4}$	5 5	4 9	$2\frac{1}{2}$	5 0	112	48
" limber	8 2 0										
Pair of wheels, light	3 2 20	43	"	"	"	"	"	$2\frac{1}{2}$	5 0	"	"
" heavy	4 1 8	47	"	"	"	"	"	$2\frac{3}{4}$	5 0	"	"
Axle	0 3 12	"	"	"	"	"	"	"	"	"	"

TABLE XIV.—$4\frac{2}{5}$-inch Mountain Howitzer.

	Weight.	Bulk as for tonnage.	Total length as placed in a gun shed.	Length of axle or extreme breadth of carriage.	Distance between fore and hind axles.	Breadth between wheels at the tires. Above.	Below.	Breadth of tire.	Diameter of wheel.	Total weight.	Total length on line of march.
	cwt. qr. lbs.	cub. ft.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	cwt.	ft.
Beds with bearing poles*	1 0 5										
Ammunition boxes, 2 large	0 2 18	20	"	"	"	"	"	"	"	"	"
" 4 small	1 0 23										

TABLE XV.

	Garrison Carriages. Iron. Weight.	Value.	Wood. Weight.	Value.	Traversing Platforms. Iron. Weight.	Value	Wood. Weight.	Value.
	cwt. qrs. lbs.	£. s. d.	cwt. qrs. lbs.	£. s. d.	cwt. qrs. lbs.	£. s. d.	cwt. qrs. lbs.	£. s. d.
32-pr. gun	23 0 22	10 17 7	13 0 2	16 0 11			25 1 2	27 11 0
24-pr. "	21 2 18	10 0 6	12 2 16	14 13 6	51 0 0	27 13 4	22 0 27	25 7 9
18-pr. "	18 1 6	9 1 6	10 2 2	12 16 2			22 0 27	25 7 9
12-pr. "	16 2 20	8 1 9	9 3 8	11 13 6	"	"	"	"
9-pr. "	14 3 $22\frac{1}{2}$	7 7 6	9 0 25	11 1 9	"	"	"	"
6-pr. "	14 2 10	6 17 6	7 2 24	9 6 6	"	"	"	"

	£. s. d.
Dwarf Traversing Platform	28 9 5
Carriage for a 32-pr. of 56 cwt. to correspond . .	23 1 11
	£51 11 4

Average of a number, £50.

* As prepared for Syria in 1840; and for Hong Kong in 1844. These beds are something like garrison carriages without trucks. One mule carries two of them, or one howitzer.

TABLE XVI.*

Garrison Carriages, &c.		Wood, (Block trail.) cwt.	qrs.	lbs.	Iron. cwt.	qrs.	lbs.
68-pr. carronade		17	2	25		,,	
42-pr. ,,		10	1	21		,,	
32-pr. ,,		8	3	24	11	3	0
24-pr. ,,		7	3	21	10	3	20
18-pr. ,,		6	3	20	9	2	10
12-pr. ,,		6	1	0	8	1	12
13-in. mortar	Old pattern.	,,	,,	,,	50	1	11½
10-in. ,,	Old pattern.	,,	,,	,,	24	0	13½
8-in. ,,	Old pattern.	,,	,,	,,	21	1	5½
5½-in. ,,		1	0	10	,,	,,	,,
4⅖-in. ,,		0	3	5	,,	,,	,,
13-in. ,,	New pattern.	,,	,,	,,	31	0	0
10-in. ,,	New pattern.	,,	,,	,,	15	2	22
8-in. ,,	New pattern.	,,	,,	,,	7	2	10

TABLE XVII.

		cwt.	qrs.	lbs.	cwt.	qrs.	lbs.
Cavalry Forge Cart					10	2	18½
Flanders Waggon					15	2	0
Small Arm Ammunition Waggon.	Limber	7	2	10	34	2	4
	Body	7	0	6½			
	20 Musket-ball boxes	2	0	16			
	20,000 Rounds of musket-ball cartridges	16	1	6			
	25,000 Percussion caps	0	1	12			
	29 Paper boxes for do.	0	0	10			
	15 sets of Horse-shoes, with nails	0	3	14			
	1 Horse-shoe box	0	0	13½			
Note.—When flints are sent in lieu of percussion caps, the weight would be for	2000 Flints	0	2	16	0	3	9½
	2 Flint boxes	0	0	21½			
Sling Cart					16	1	17
Sling Waggon, Improved, substituted for the Large Devil Carriage					31	0	23
Gyns, Triangle.	Large	9	2	22½	12	2	19½
	Blocks, &c.	2	3	25			
	Small	7	3	3	10	2	4
	Blocks, &c.	2	3	1			
Platform Waggon					21	1	23
Devil Carriage, complete, small					7	2	8
Baggage Cart					9	0	8
Store Limber Carriage.	Body	10	3	8	18	3	18
	Limber	8	0	10			
Blanshard's Pontoon large Carriage		13	2	24	42	2	12
	Appurtenances	28	3	16			
Ditto ditto small Carriage		9	0	0	22	2	5
	Appurtenances	13	2	5			
Hand Cart					4	3	4

* From Griffiths' 'Artillerist's Manual,' third edition.

32, 24, & 18, POUNDER GARRISON CARRIAGE.
(IRON) as at present Jan.y 1843.

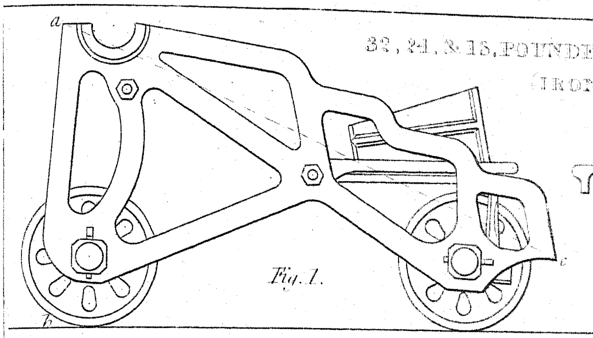


Fig. 1.

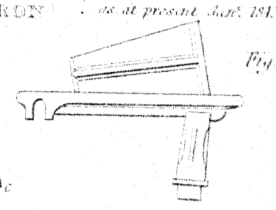


Fig. 2.

Steel bed and Quoin

a b in all is about 3..1
a c in 32 & 24 Pounder about 6..6
18 & 12 Pounder about 5..9
9 & 6 D° D° 5..4½
Few Carriages measure exactly alike.

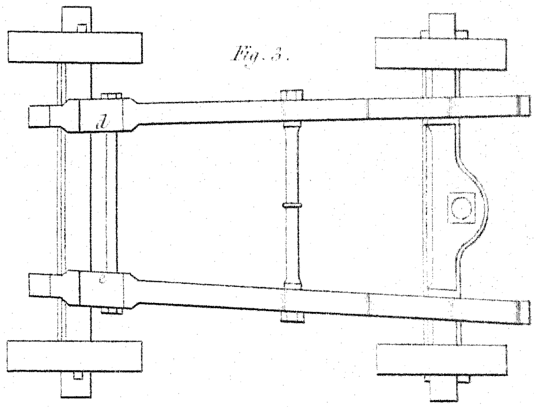


Fig. 3.

Fig. 4.

For d e in figs 3 8 see Artillery Tables A.B.C. for the diameter of the Gun at this point.

Fig. 6.

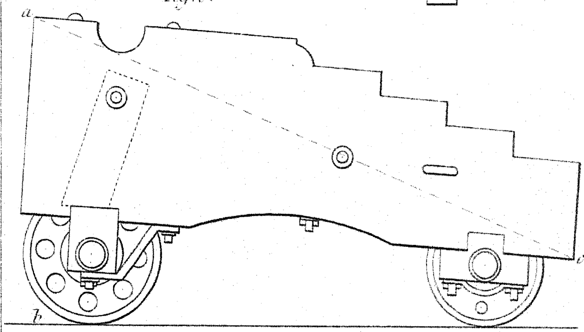
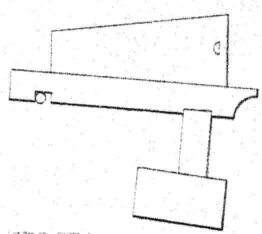


Fig. 7.
Quoin on Steel bed



32, 24, & 18, POUNDER GARRISON CARRIAGE. (WOOD)

a b as above in all
a c in 32 & 24 P.r 6..7
18 P.r 6..3

Fig. 8.

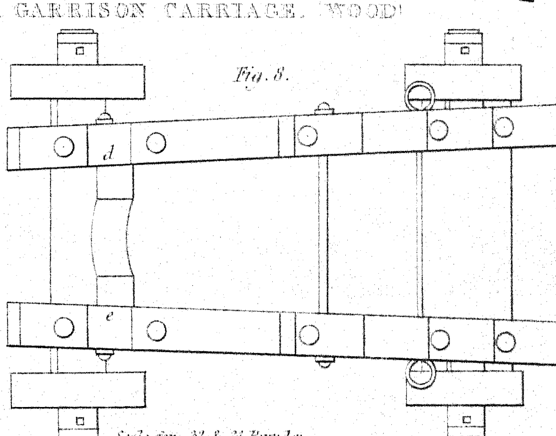
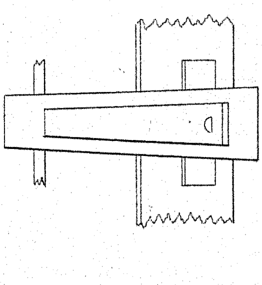
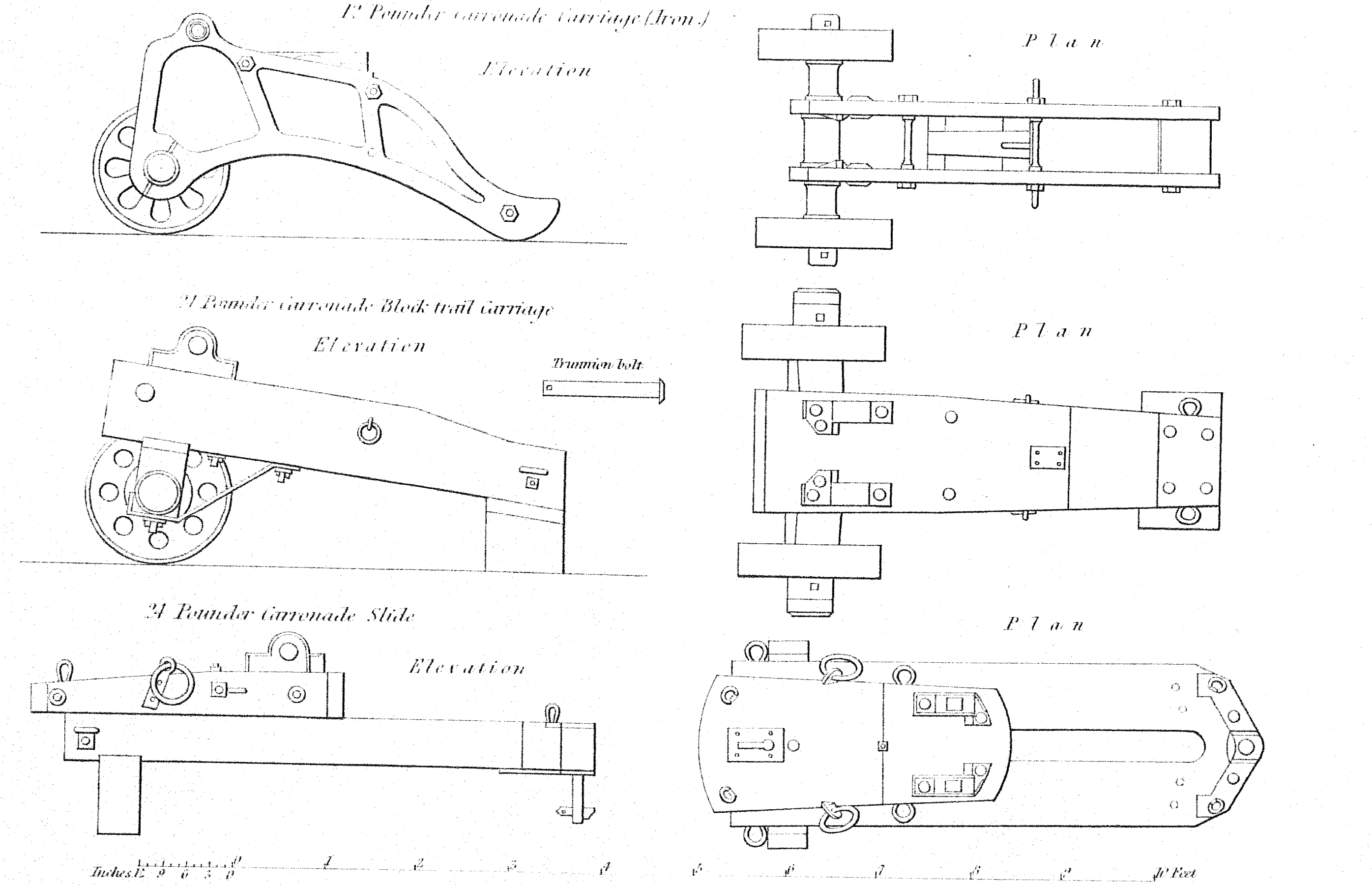


Fig. 9.



Scale for 32 & 24 Pounder.
Inches 12 6 0 1 2 3 4 5 6 Feet


12 Pounder Carronade Carriage (Iron.)
Elevation
Plan
24 Pounder Carronade Block trail Carriage
Elevation
Trunnion bolt
Plan
24 Pounder Carronade Slide
Elevation
Plan
Inches 12 9 6 3 0 1 2 3 4 5 6 7 8 9 10 Feet

13 INCH LAND SERVICE MORTAR BED.

Fig. 1.

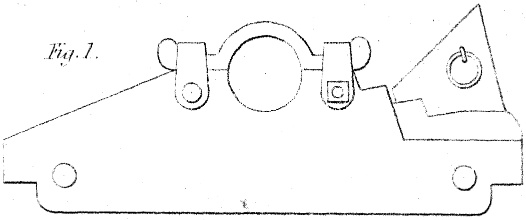
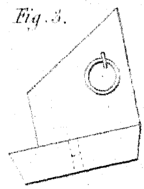


Fig. 3.



Quein on Transom

Fig. 2.

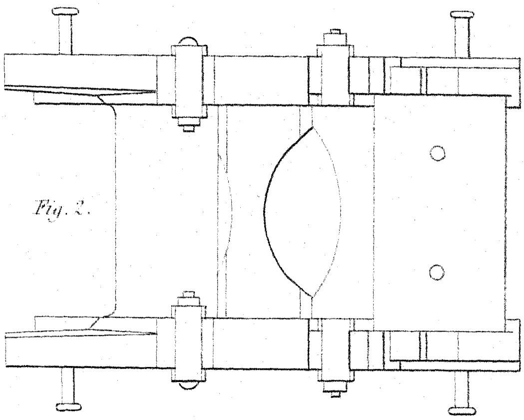
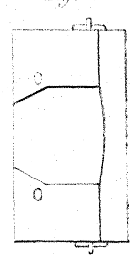
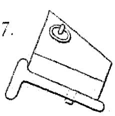


Fig. 4.



10 INCH LAND SERVICE MORTAR BED (NEW PATTERN)

Fig. 7.



Quein

Fig. 5.

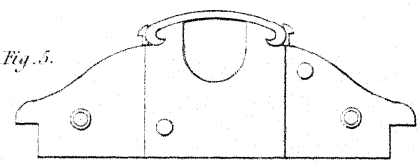


Fig. 8.

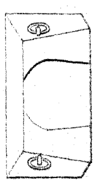
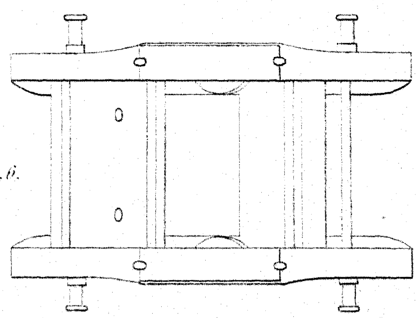


Fig. 6.

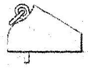


Elevation

Without Quein ...... 15°

With Quein ...... 45°

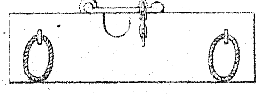
$5\frac{1}{2}$ INCH MORTAR BED (WOOD)



Quein

Fig. 12.

Fig. 9.



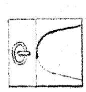


Fig. 11.

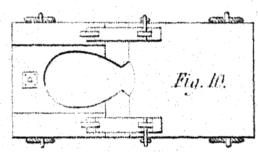
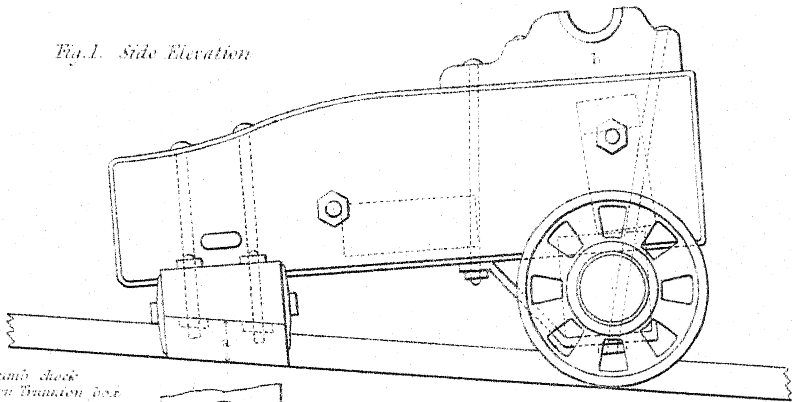


Fig. 10.

8 INCH IRON HOWITZER (Millar)

Garrison Carriage on a Traversing Platform.

Fig. 1. Side Elevation



a Dumb check
b Iron Trunnion box

Fig. 2 Plan.

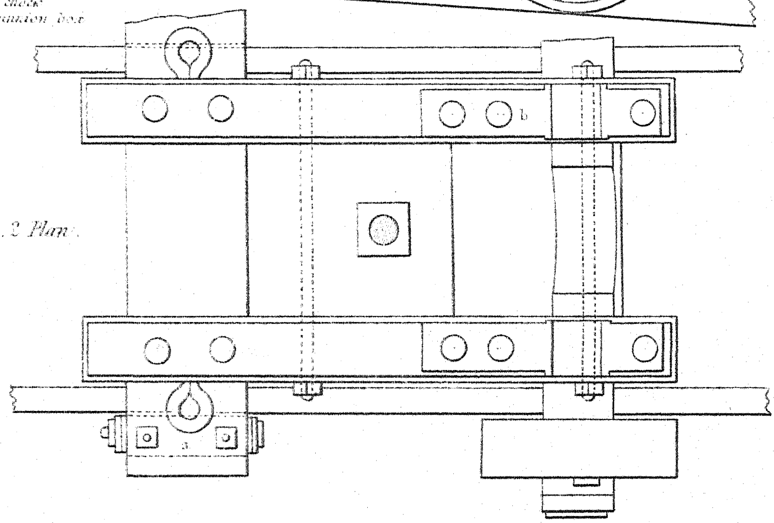
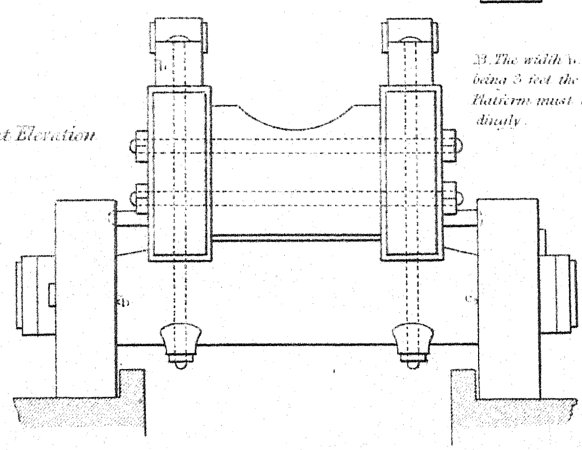


Fig. 3. Front Elevation



N.B. The width i.e. between the wheels being 3 feet the width of the traversing Platform must be regulated Accordingly.

0 1 2 3 4 5 Feet

24 POUNDER HOWITZER.

GARRISON CARRIAGE.

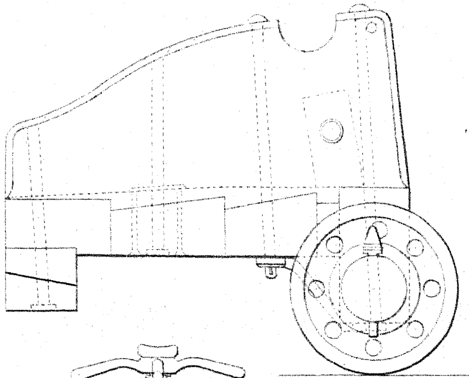


Fig. 1.
Side Elevation

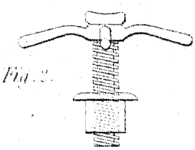


Fig. 2.

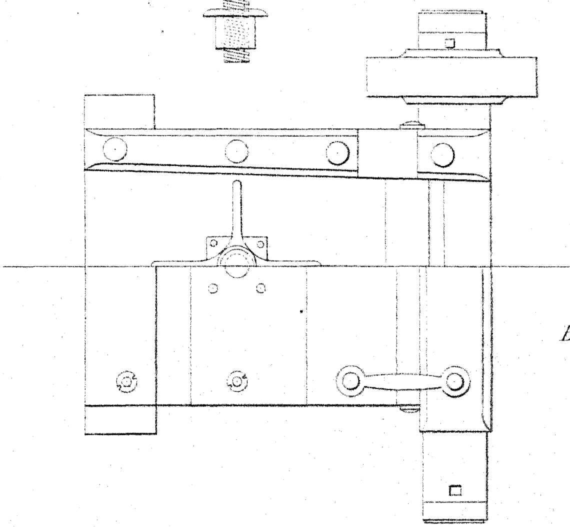


Fig. 3.
Top Plan.

Fig. 4.
Bottom Plan.

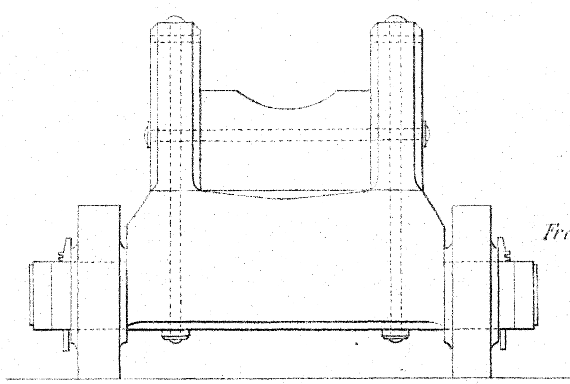
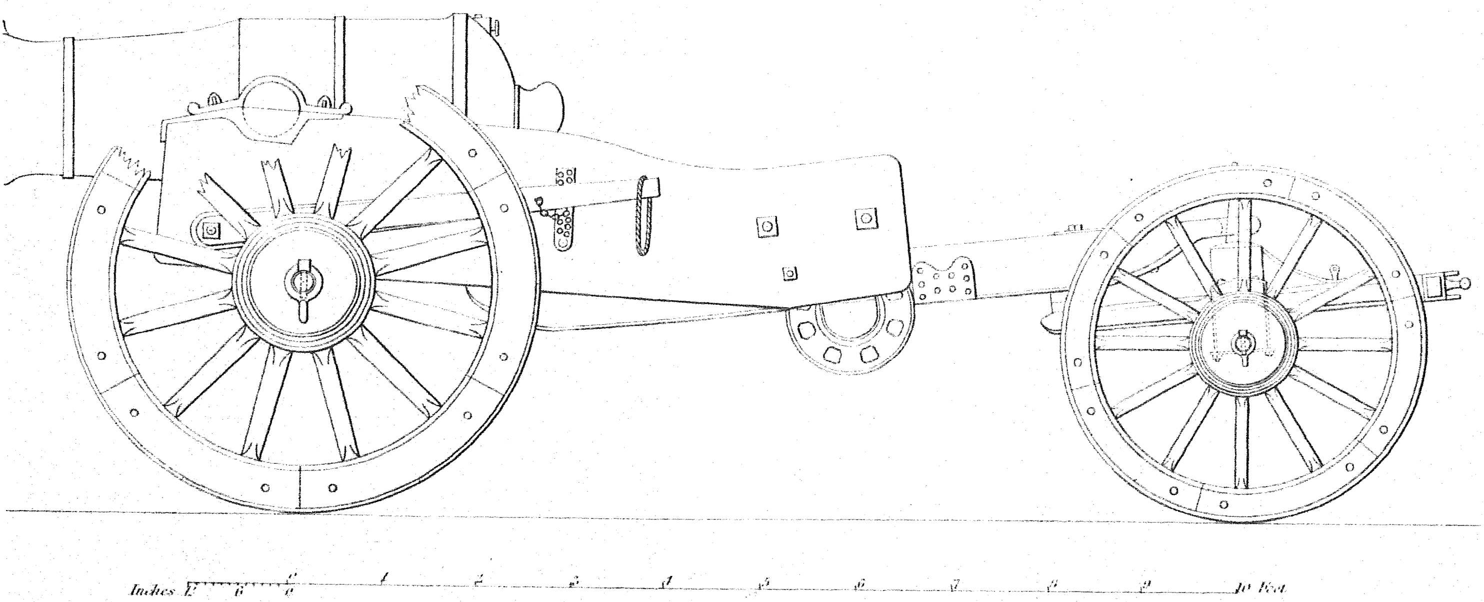


Fig. 5.
Front Elevation.

0 1 2 3 Feet

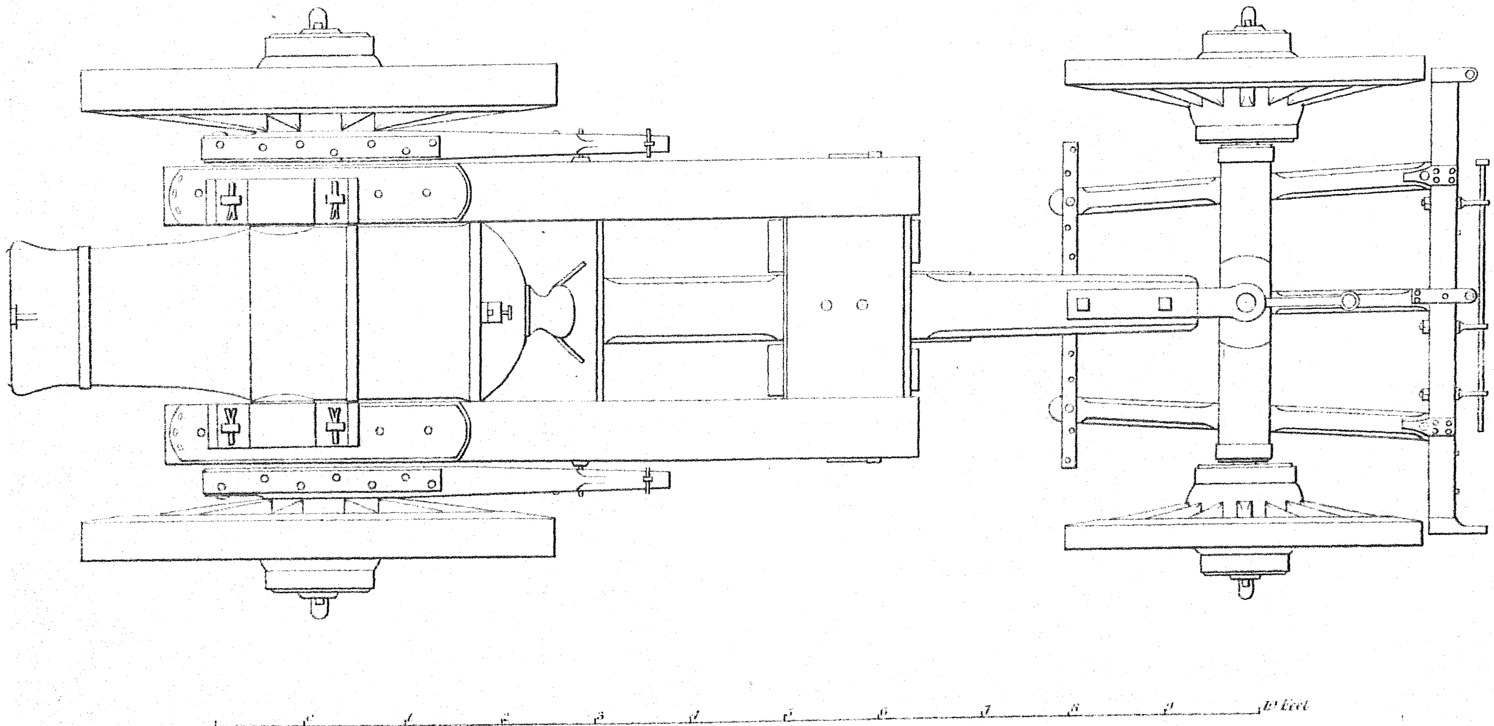
10 INCH HOWITZER.

Elevation.



10 INCH HOWITZER.

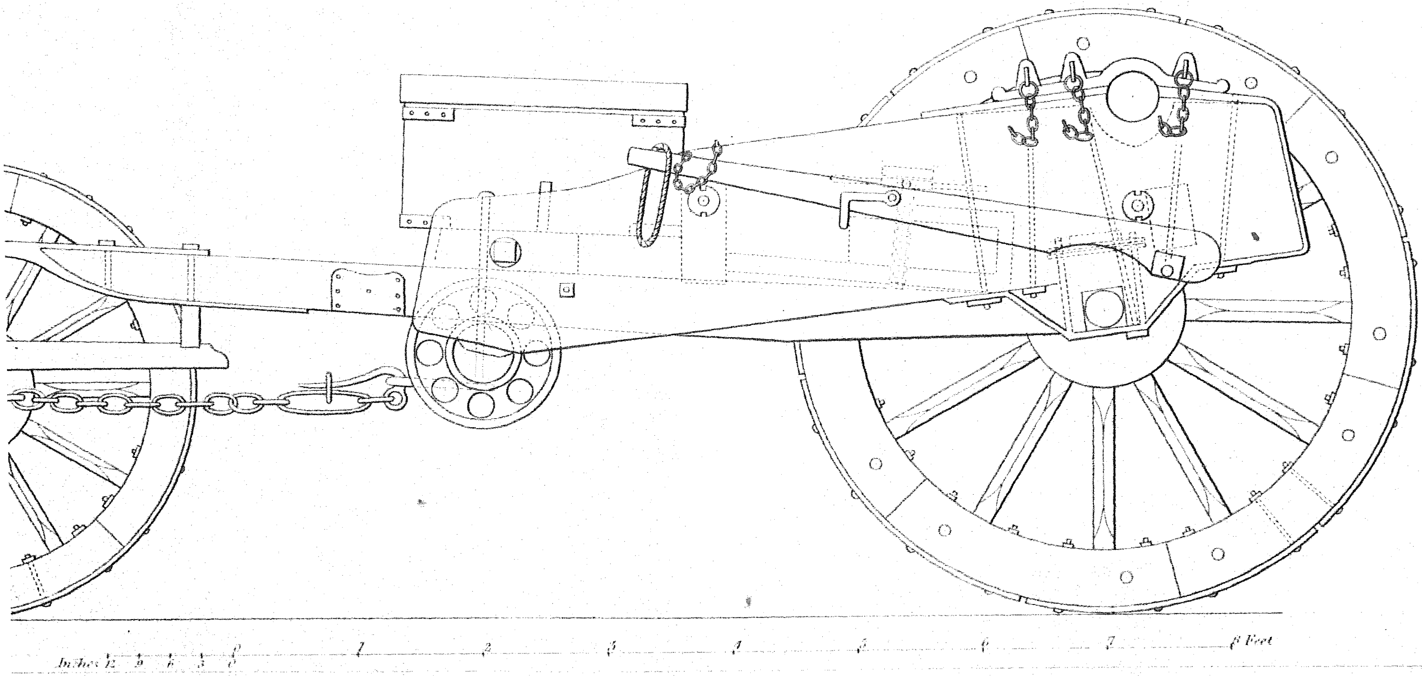
Plan.



For length of Shafts see Plates 23. & 24.

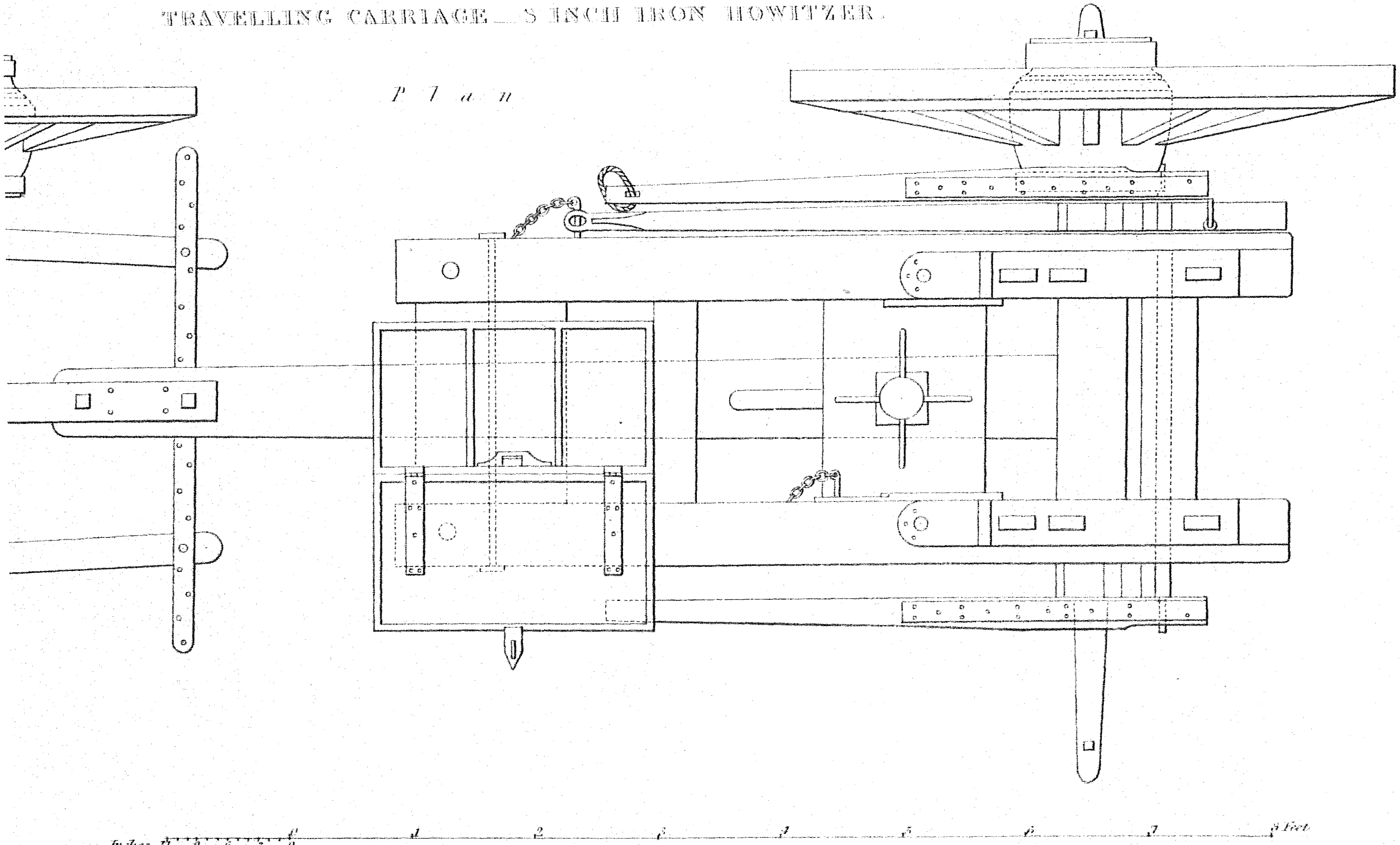
TRAVELLING CARRIAGE 8 INCH IRON HOWITZER.

Elevation



TRAVELLING CARRIAGE _ 8 INCH IRON HOWITZER.

Plan

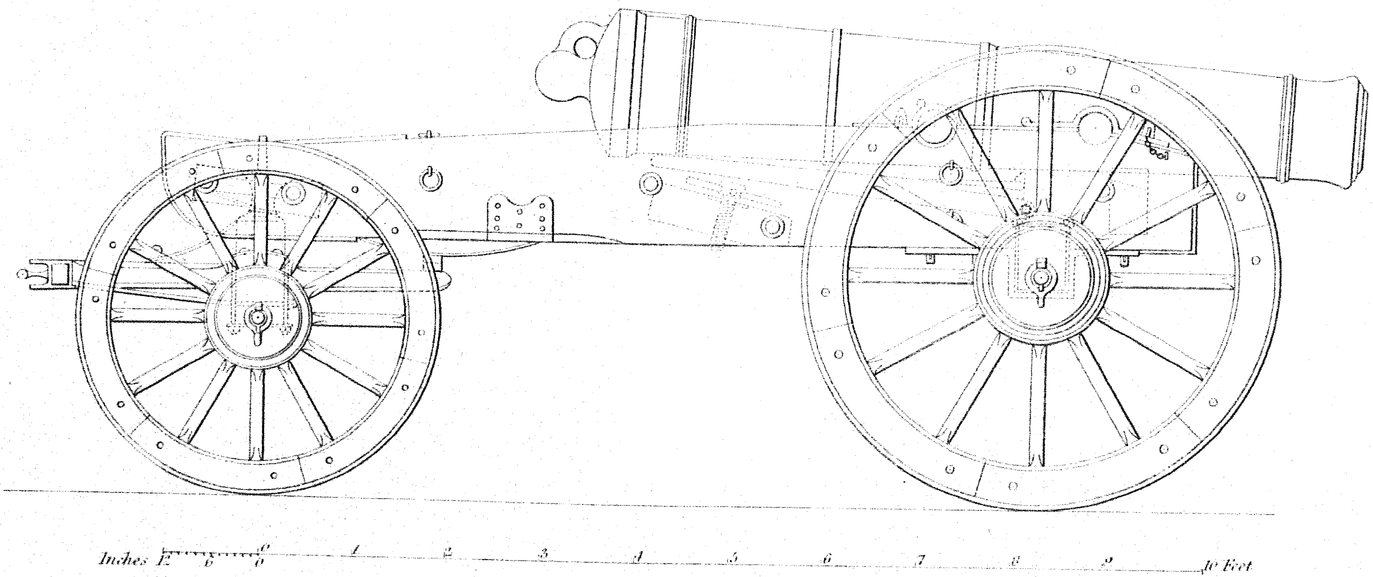


For length of Shafts see Plates 23 & 24.

18 POUNDER.

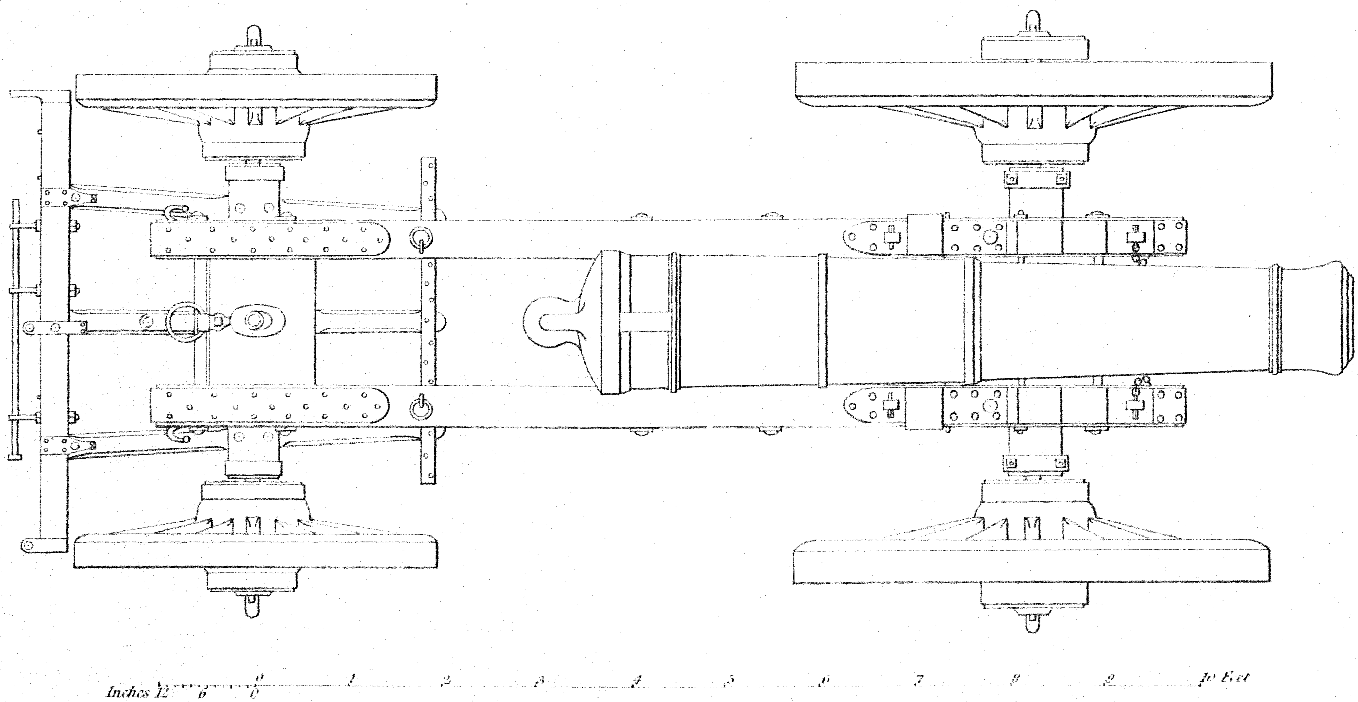
Elevation

The Limber here shewn (complete except the Shafts) serves for the 10 & 8 Inch Iron Howitzers, and for the 24 P.r Iron Siege Gun:—this plate should have consisted of the Limber only.



18 POUNDER.

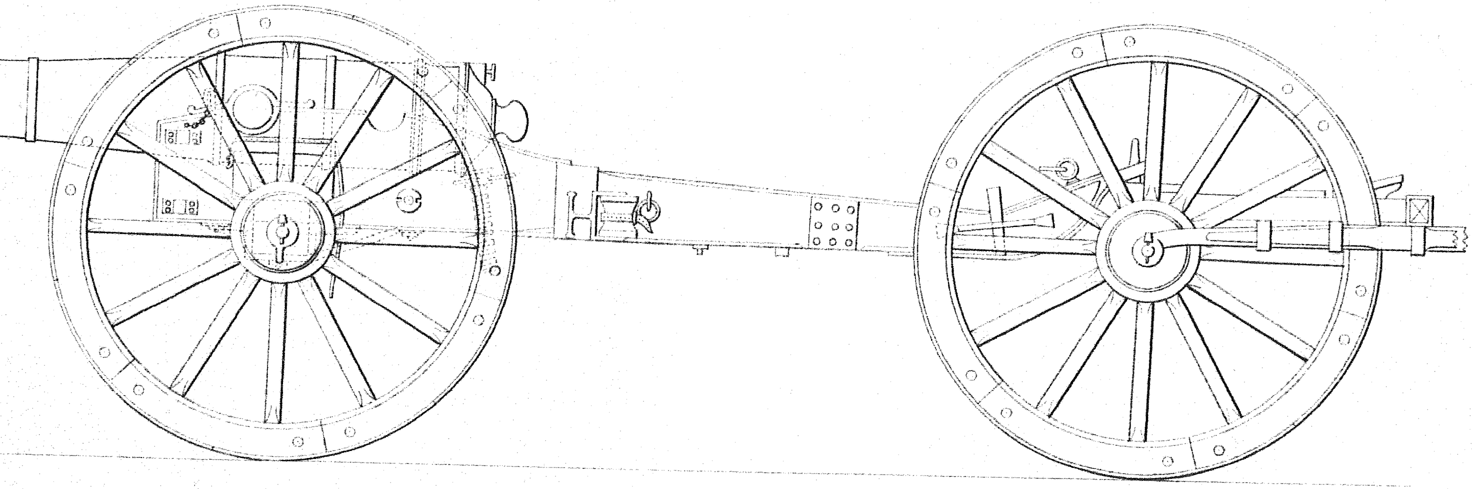
Plan.



For length of Shafts see Carriage Plates 23. 24.

32 POUNDER HOWITZER.

Elevation

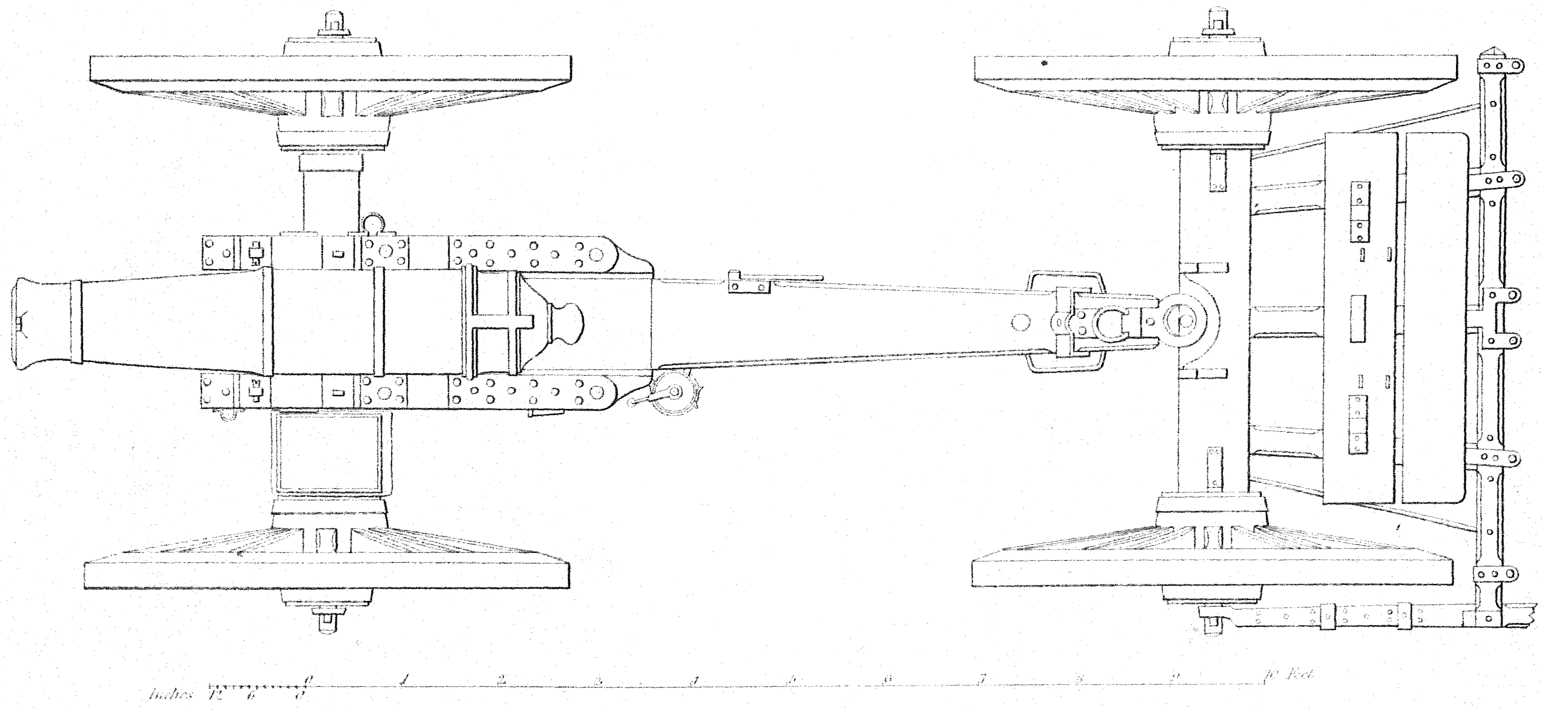


Inches 12 6 0 1 2 3 4 5 6 7 8 9 10 Feet

For length of Shafts See Carriage Plates 23, 24.

32 POUNDER HOWITZER.

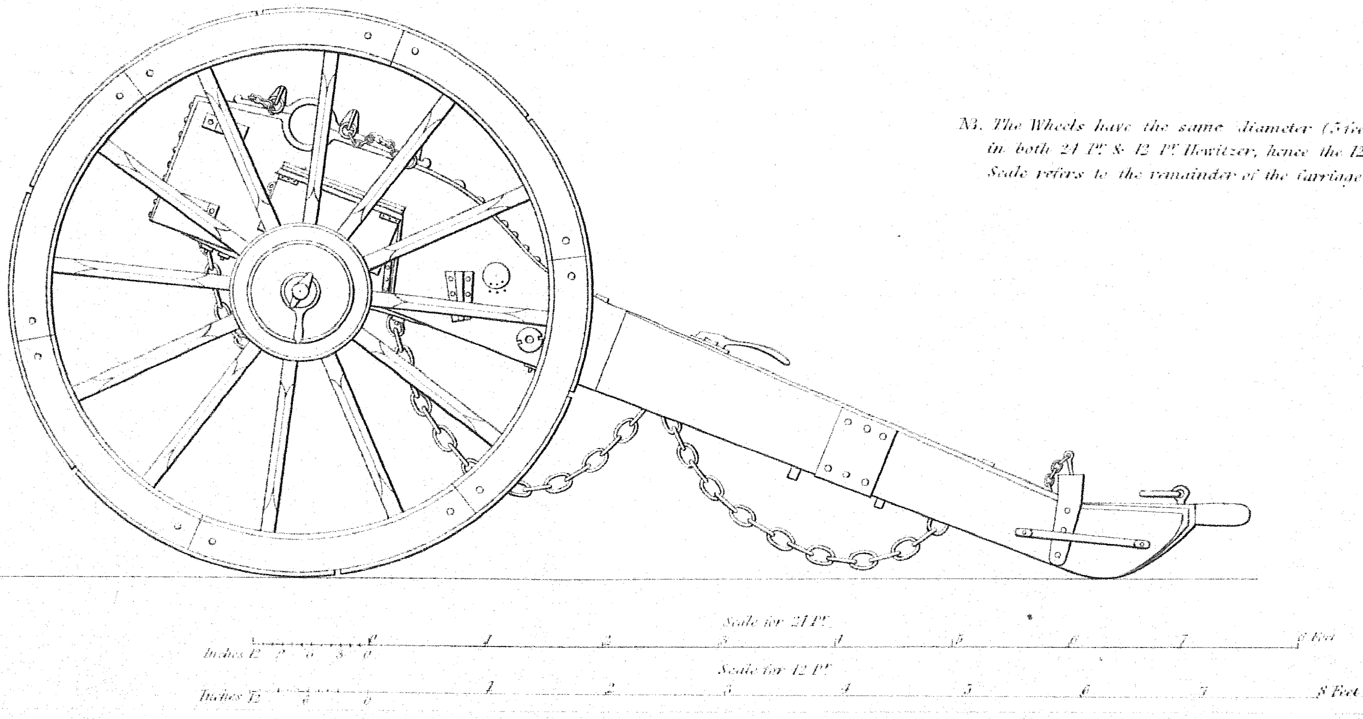
Plan



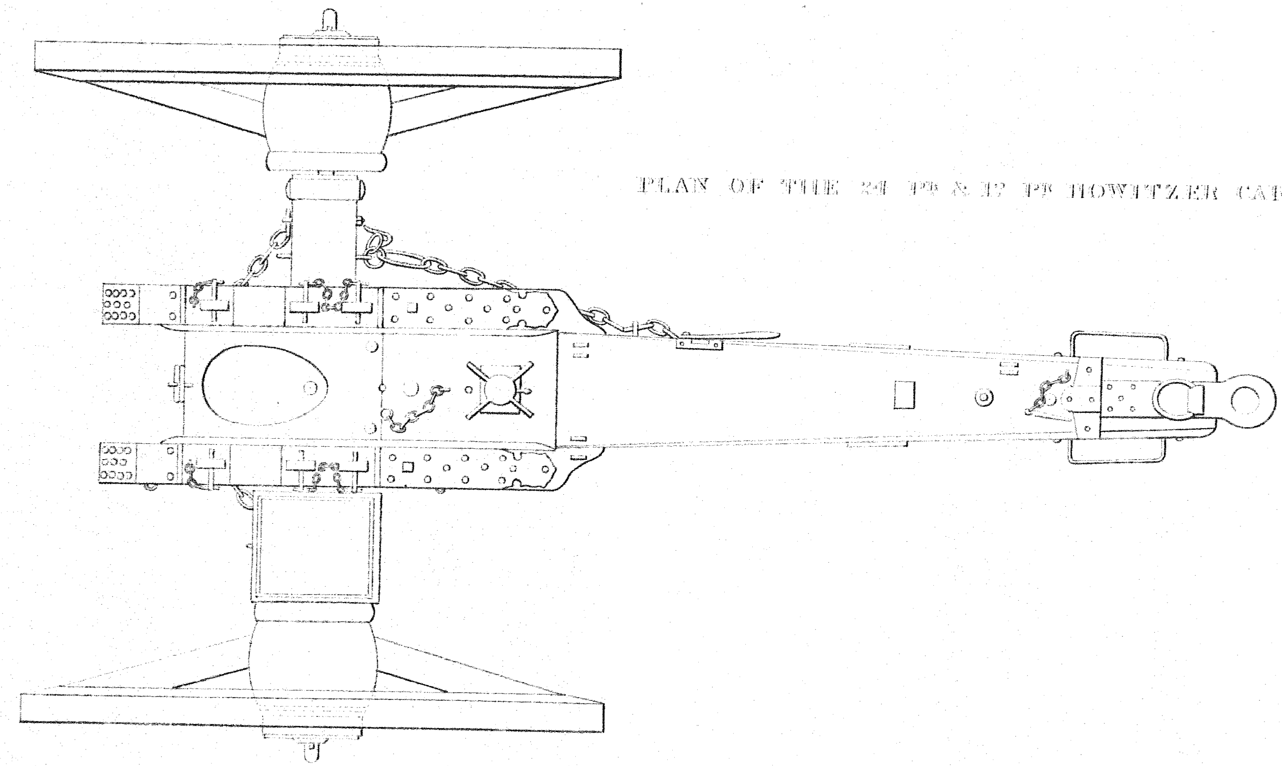
For length of Shafts see Carriage Plates 23, 24.

ELEVATION OF THE 24 P^R & 12 P^R HOWITZER CARRIAGE.

N.B. The Wheels have the same diameter (5 feet) in both 24 P^r & 12 P^r Howitzer, hence the 12 P^r Scale refers to the remainder of the Carriage only.



PLAN OF THE 24 Pr & 12 Pr HOWITZER CARRIAGE.

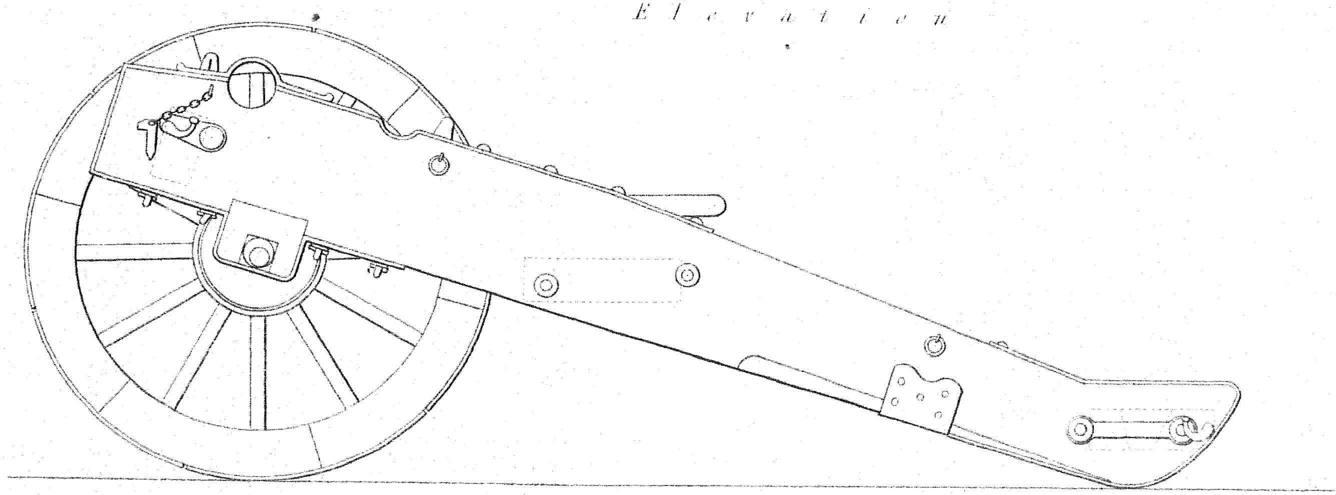


Scale for 24 Pr
Inches 12 9 6 3 0 1 2 3 4 5 6 7 8 Feet

Scale for 12 Pr
Inches 12 6 0 1 2 3 4 5 6 7 8 Feet

24 POUNDER SIEGE CARRIAGE.

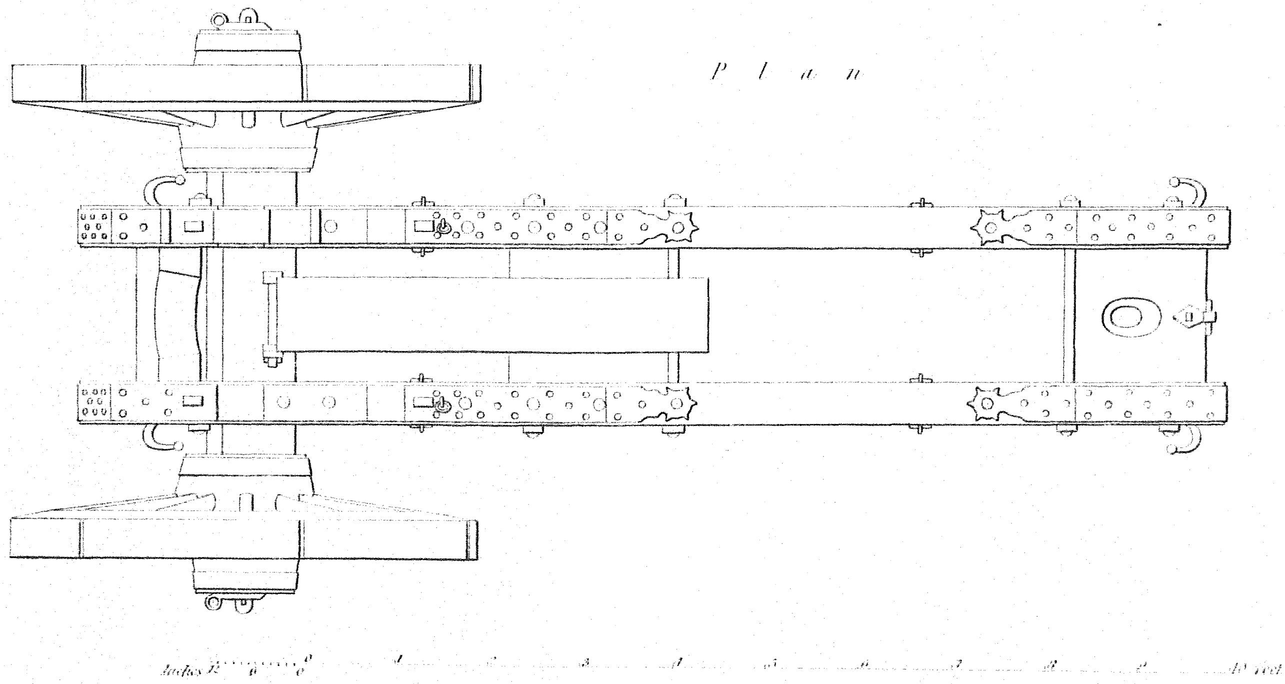
Elevation

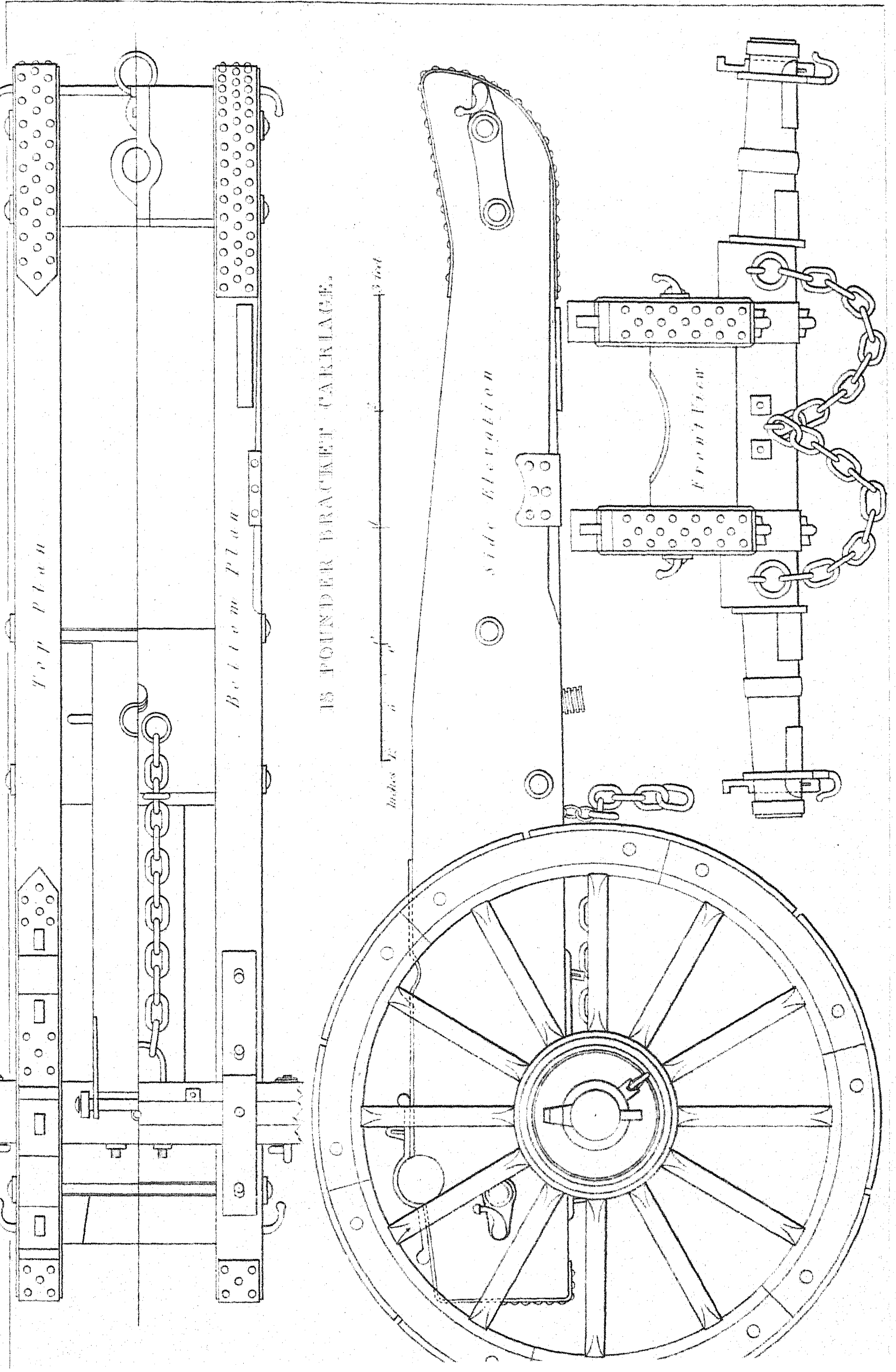


Inches 12 9 6 3 0 1 2 3 4 5 6 7 8 9 10 Feet

24 POUNDER SIEGE CARRIAGE.

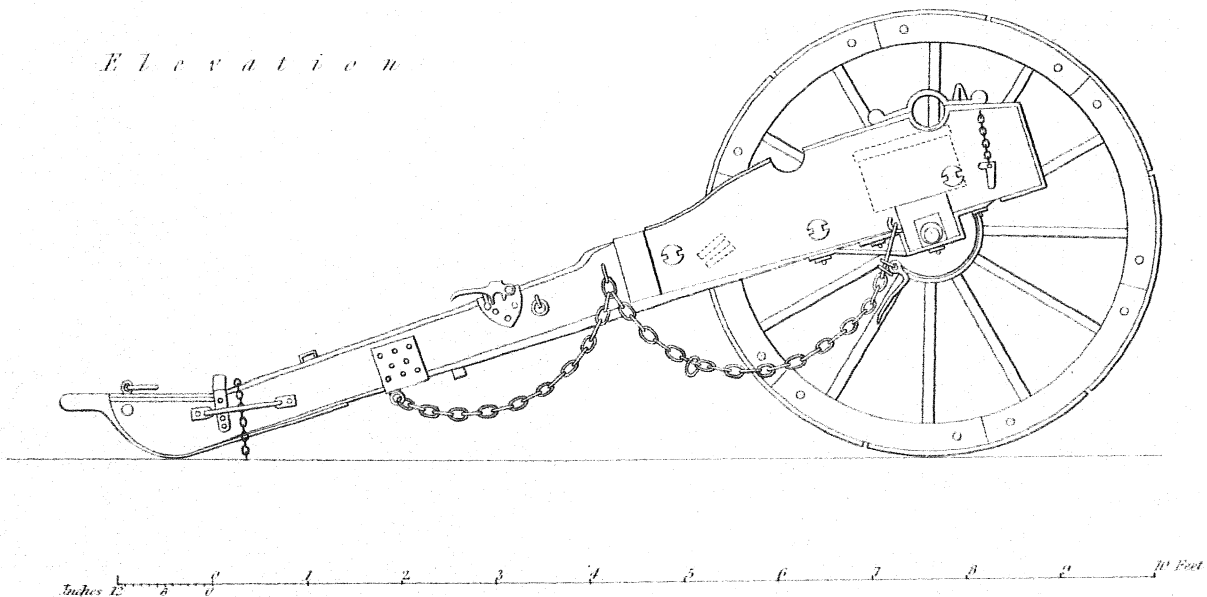
Plan




18 POUNDER BRACKET CARRIAGE.
Top Plan
Bottom Plan
Side Elevation
Front View

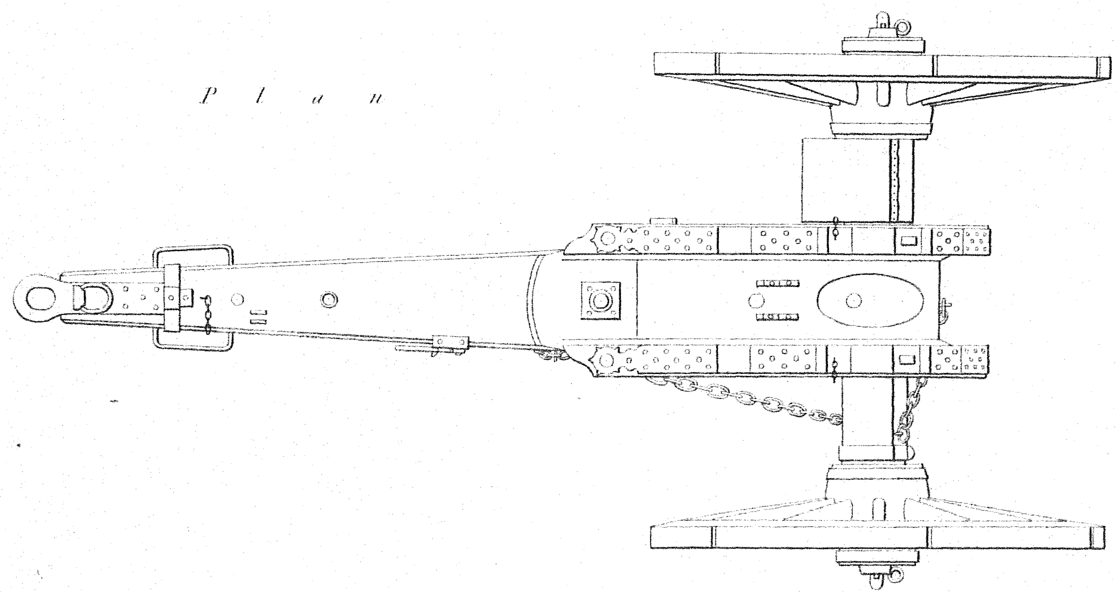
12 POUNDER FIELD CARRIAGE.

Elevation



12 POUNDER FIELD CARRIAGE.

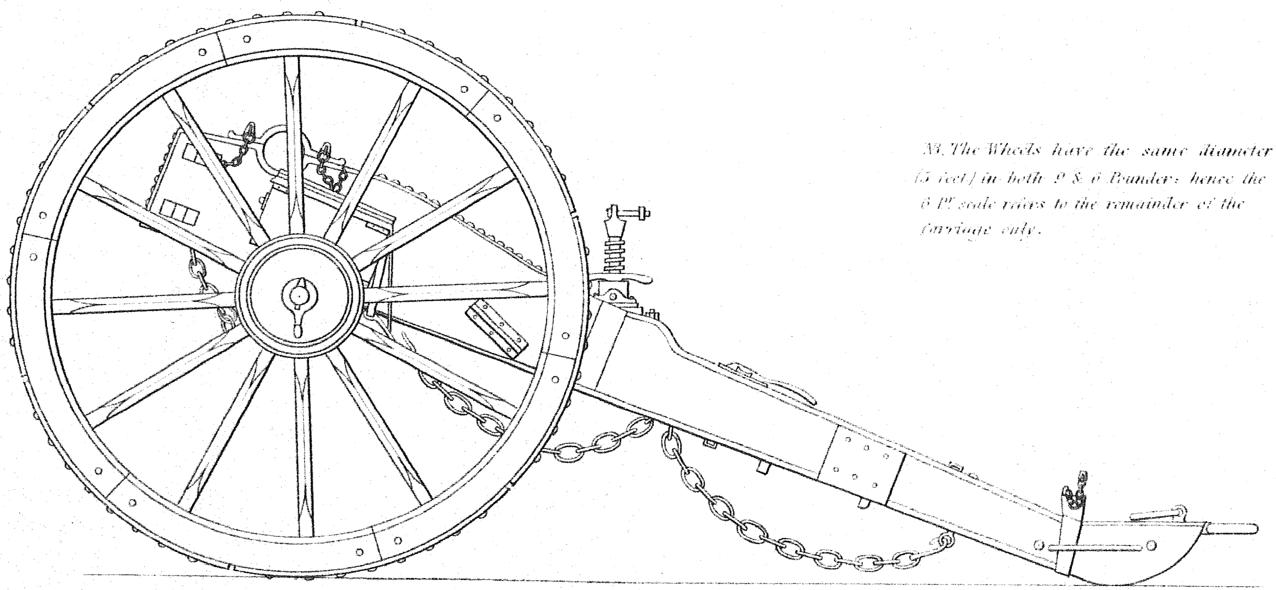
Plan



Inches 12 6 0 — 1 2 3 4 5 6 7 8 9 10 Feet

N.B. *Diameter of Wheel should have been 5 feet.*

ELEVATION OF GUN CARRIAGE FOR 9 P^R & 6 P^R FIELD GUN.

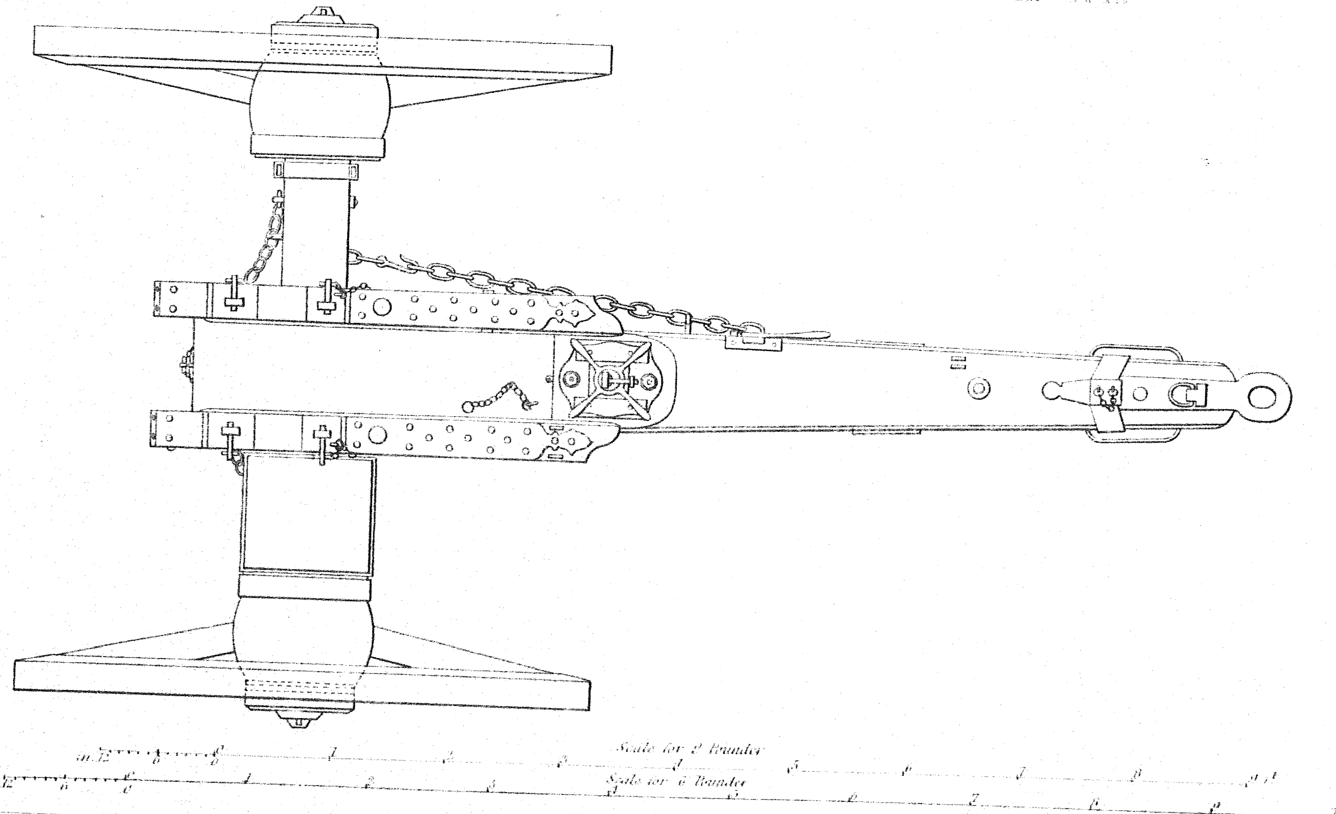


N.B. The Wheels have the same diameter (5 feet) in both 9 & 6 Pounder: hence the 6 P^r scale refers to the remainder of the carriage only.

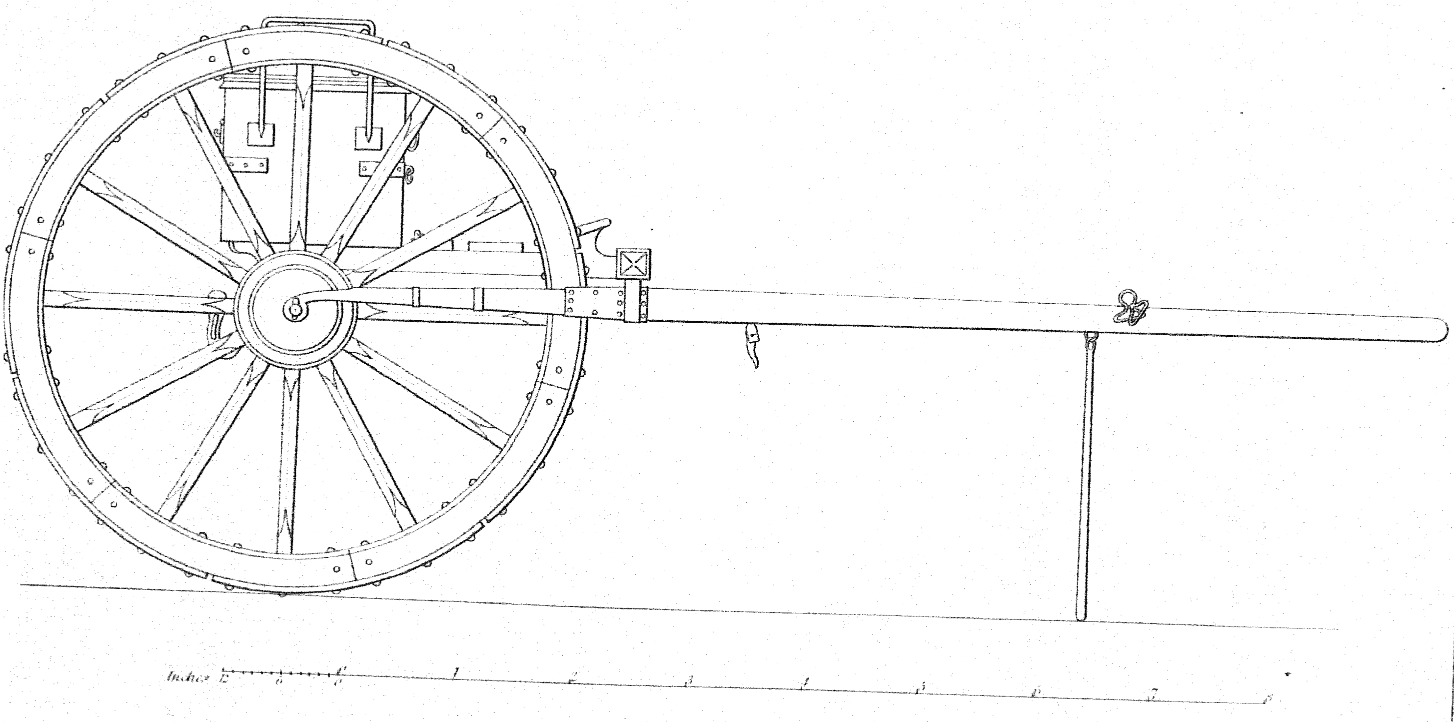
Scale for 9 Pounder

Scale for 6 Pounder

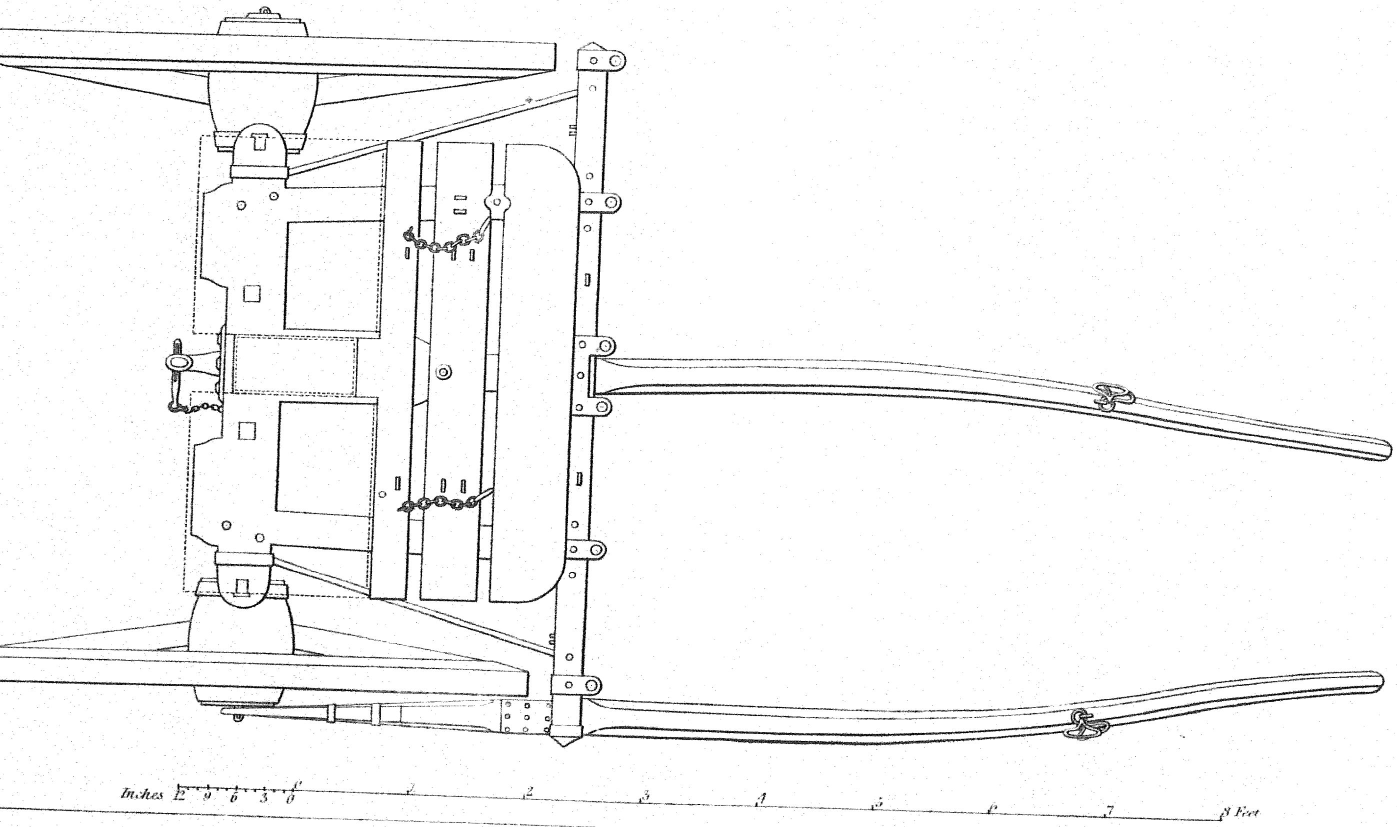
PLAN OF GUN CARRIAGE FOR 9 P^R & 6 P^R FIELD GUN.

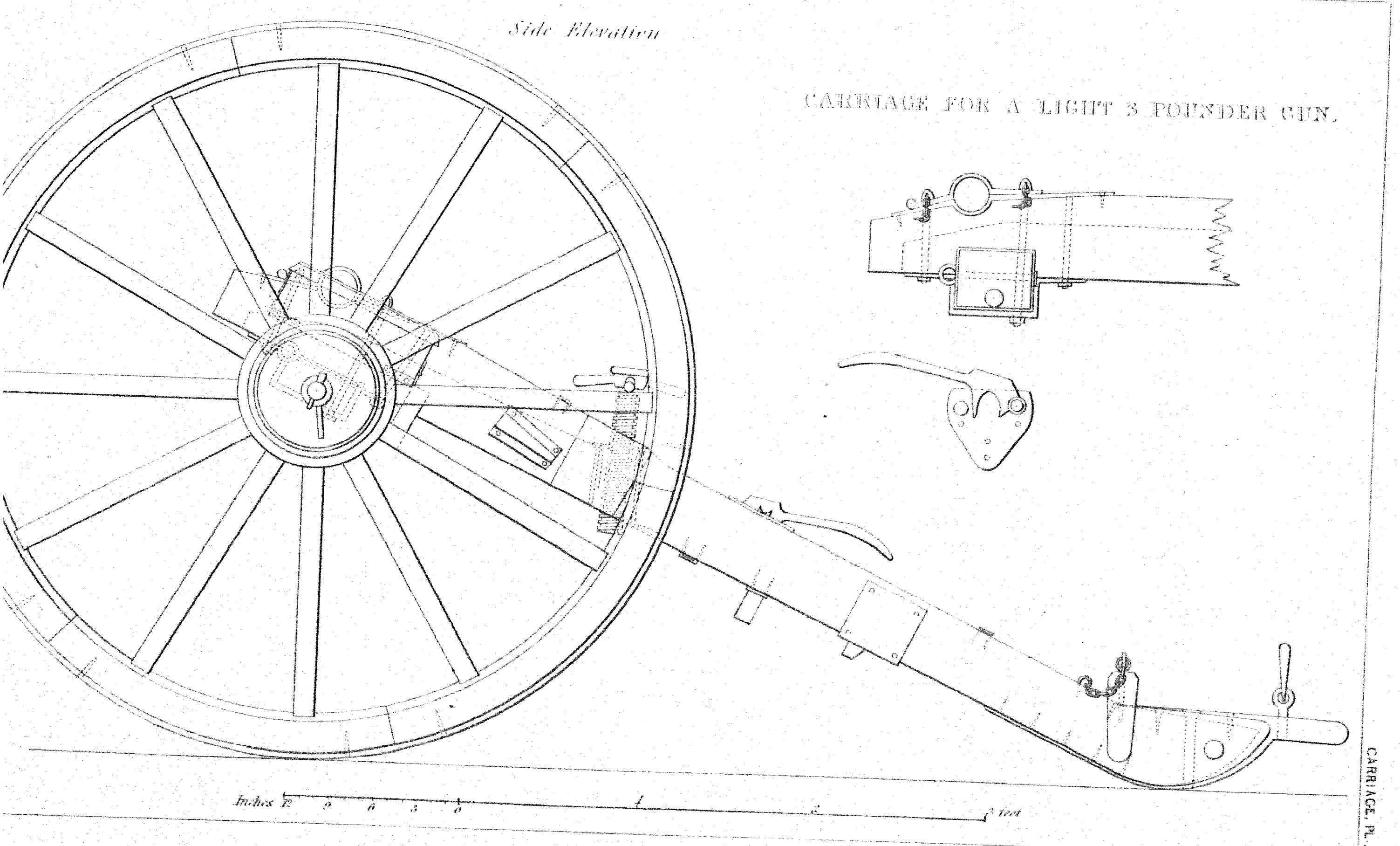


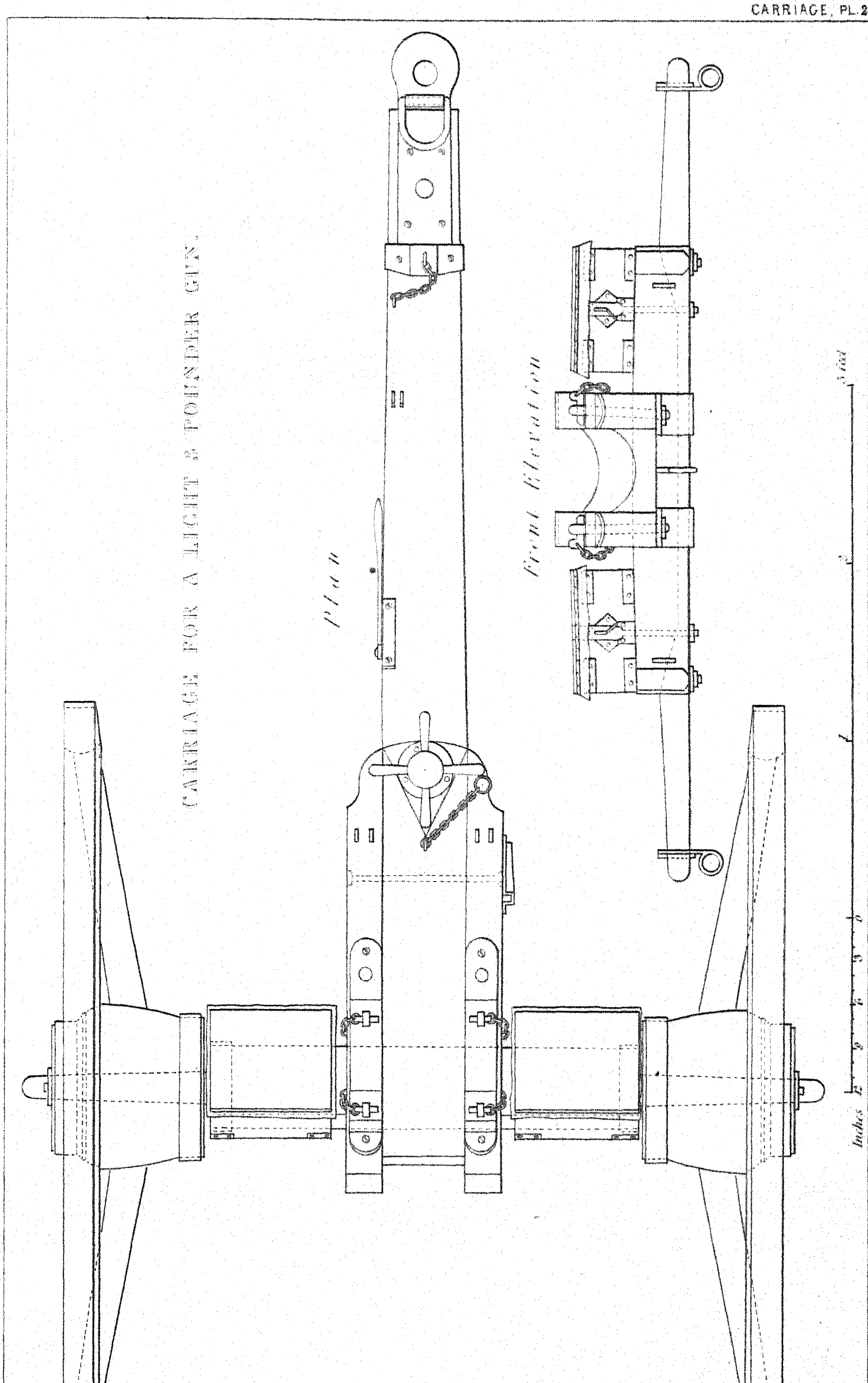
ELEVATION OF LIMBER _ 9 P^R FIELD GUN.



PLAN OF LIMBER _ 9 P^R FIELD GUN.

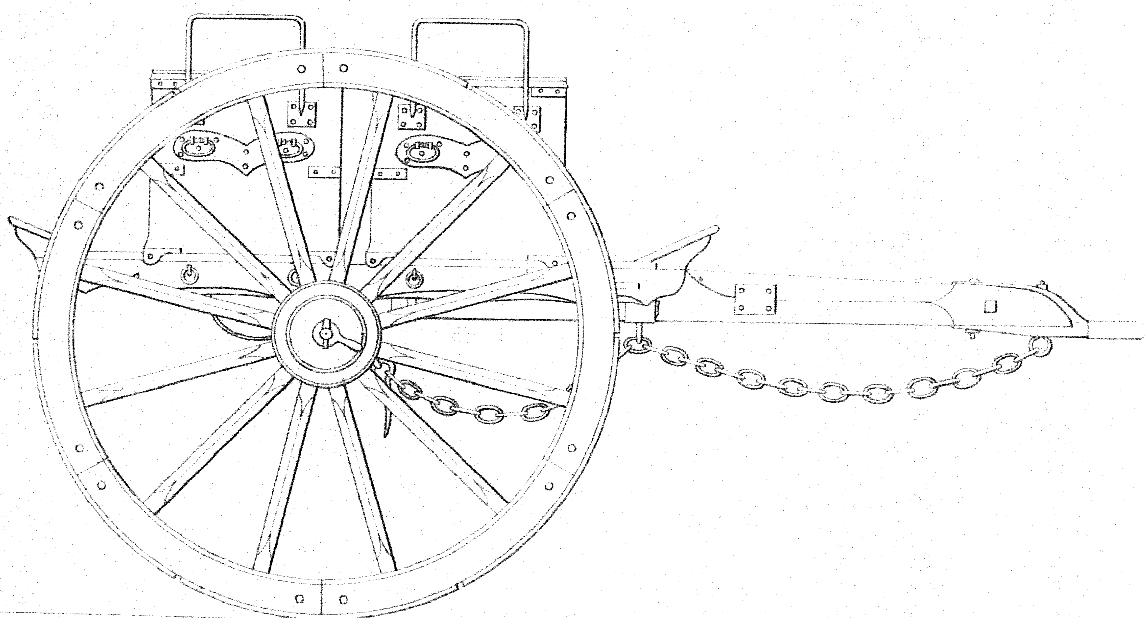



CARRIAGE FOR A LIGHT 3 POUNDER GUN.
Side Elevation
Inches 12 9 6 3 0 1 2 3 feet

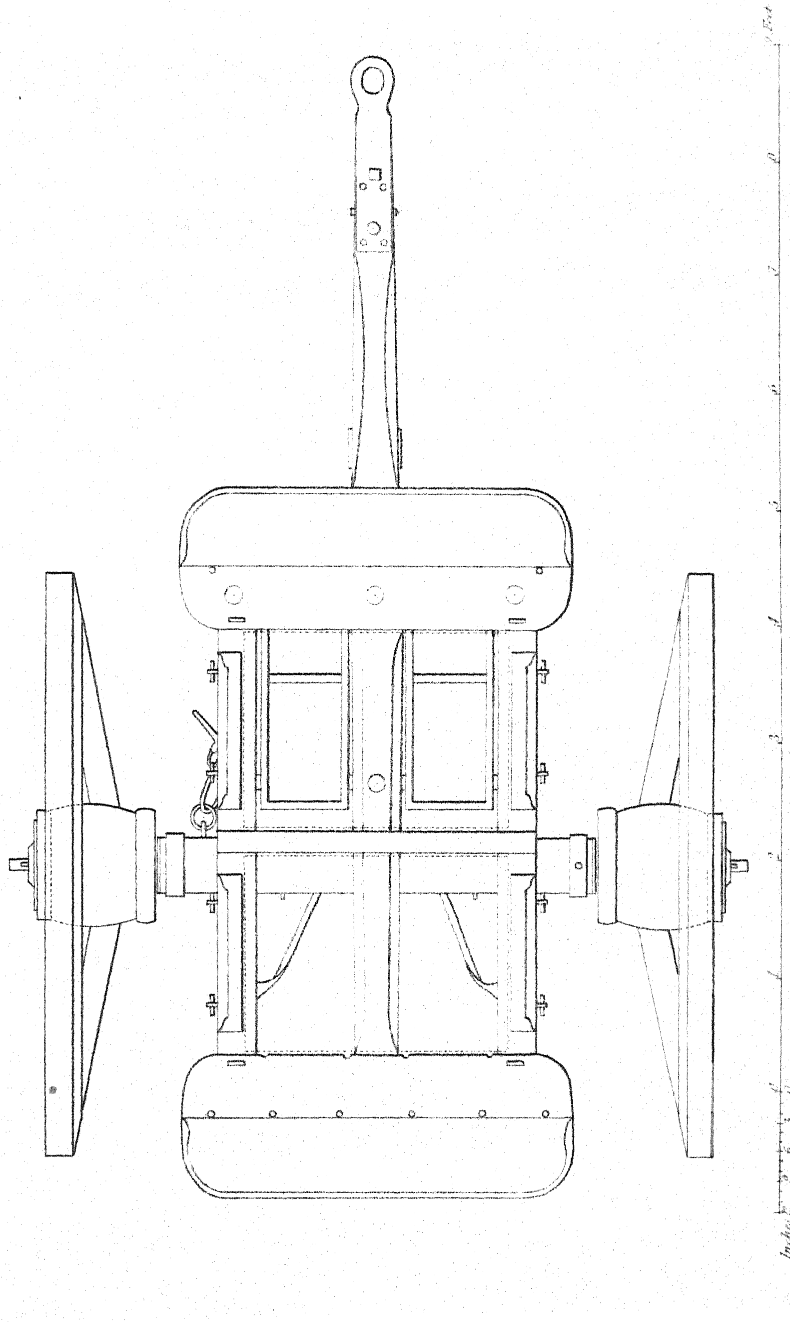


CARRIAGE FOR A LIGHT 3 POUNDER GUN.

ELEVATION OF AMMUNITION WAGGON.

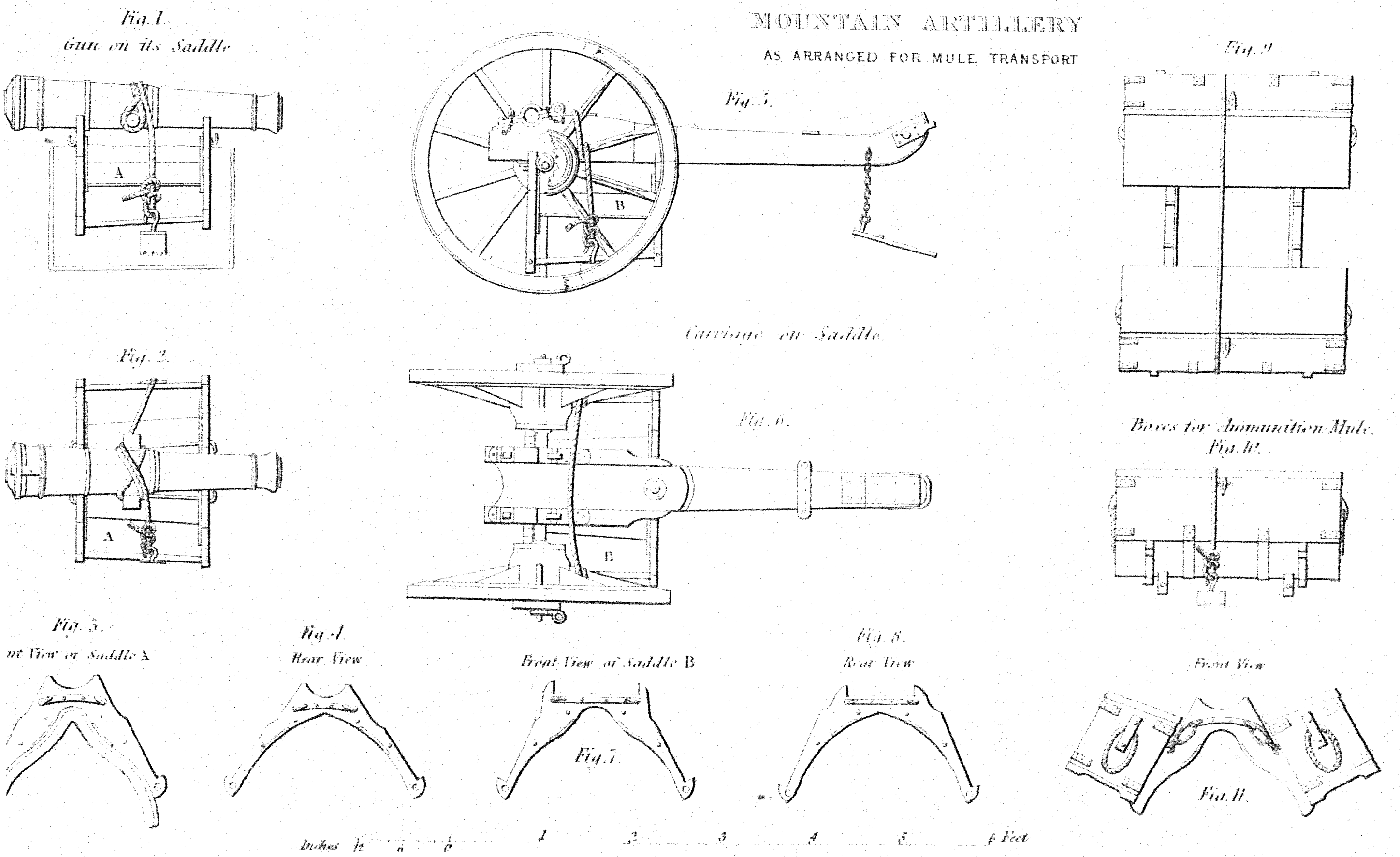


PLAN OF AMMUNITION WAGGON.



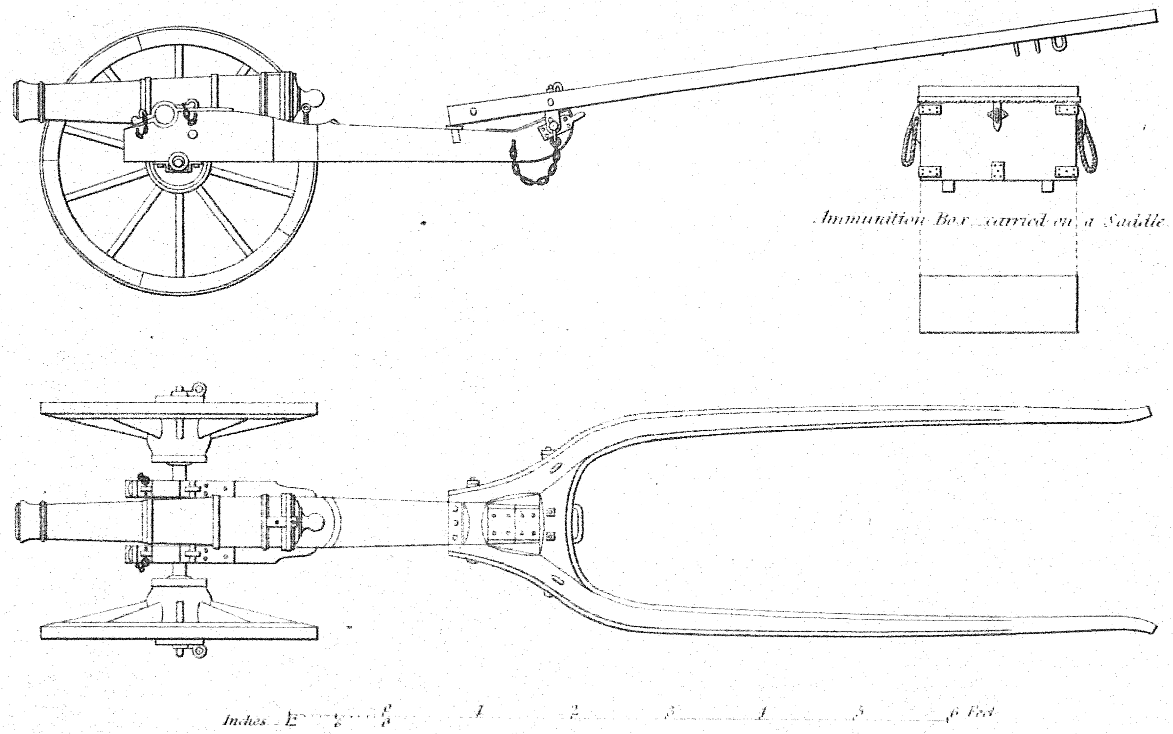
MOUNTAIN ARTILLERY

AS ARRANGED FOR MULE TRANSPORT



ELEVATION & PLAN OF A LIGHT 3 POUNDER (MOUNTAIN SERVICE.)

SHAFT TO THE TRAIL



12 Pr ROCKET CARRIAGE.

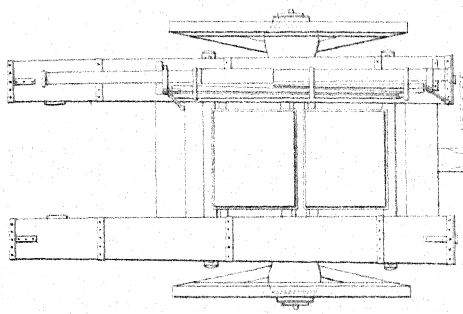


Fig. 1. Plan

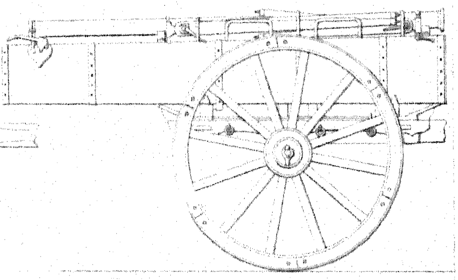


Fig. 2. Elevation

6 Pr ROCKET CARRIAGE.

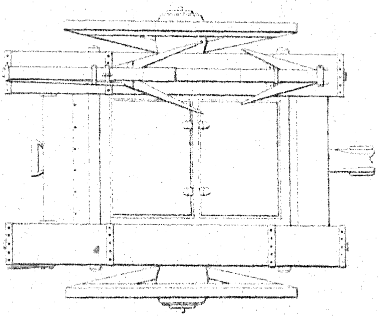


Fig. 3. Plan

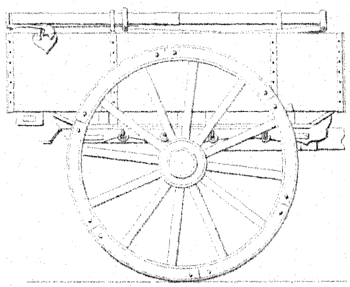
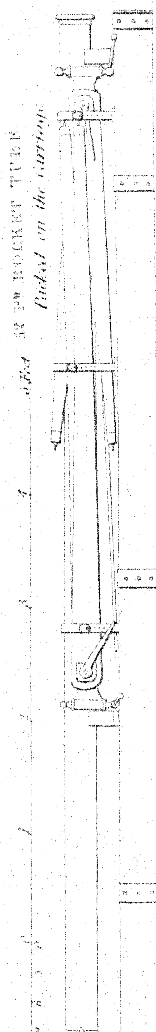
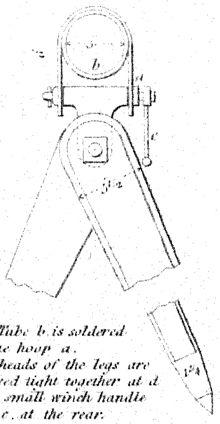


Fig. 4. Elevation



Front Elevation of Front legs



The Tube b is soldered to the hoop a.
The heads of the legs are screwed tight together at d by a small winch handle like c, at the rear.

12 Pr ROCKET TUBE.

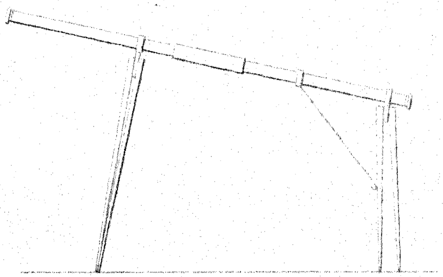
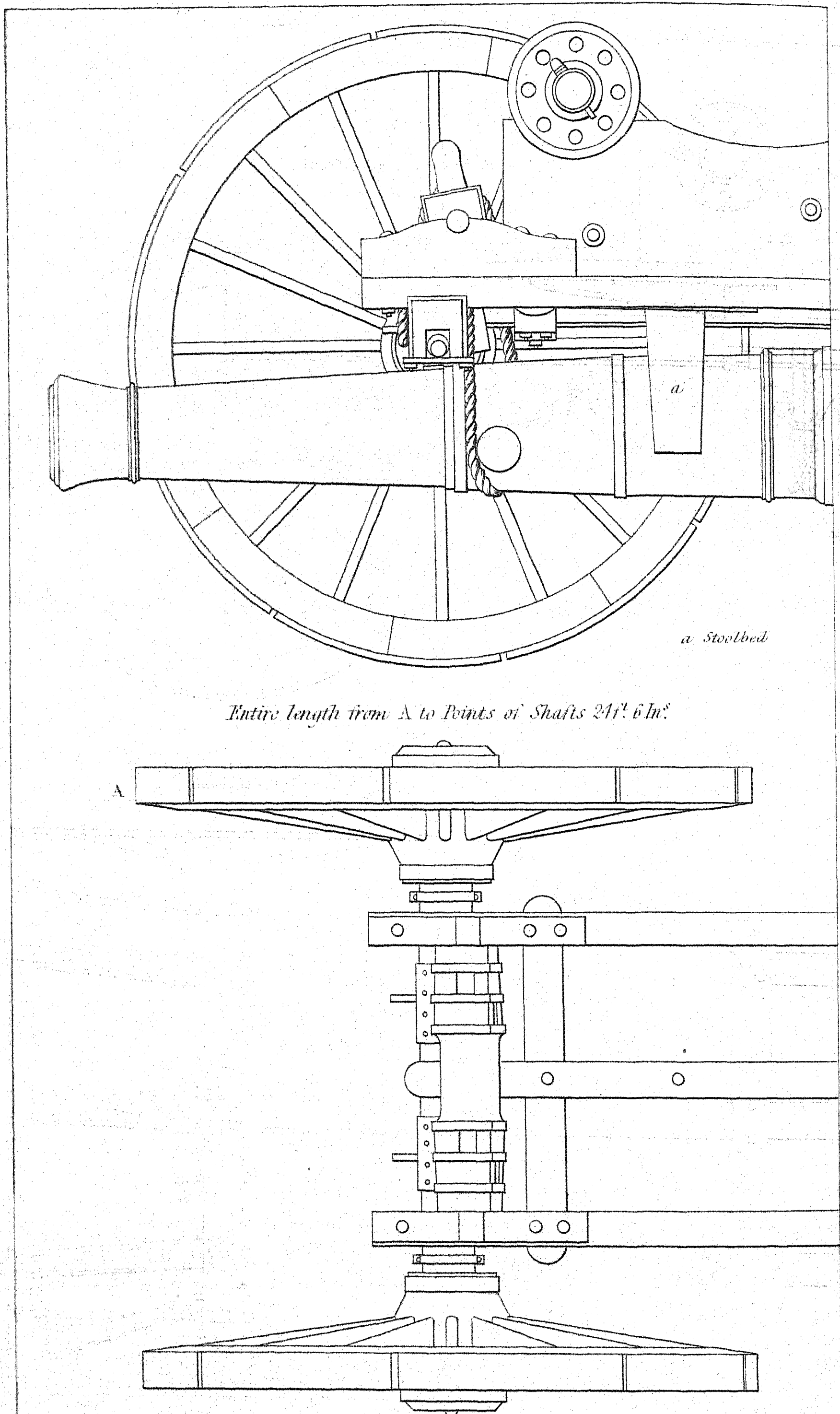


Fig. 5. Side Elevation

Scale to Figs. 1, 2, 3, 4, 5.

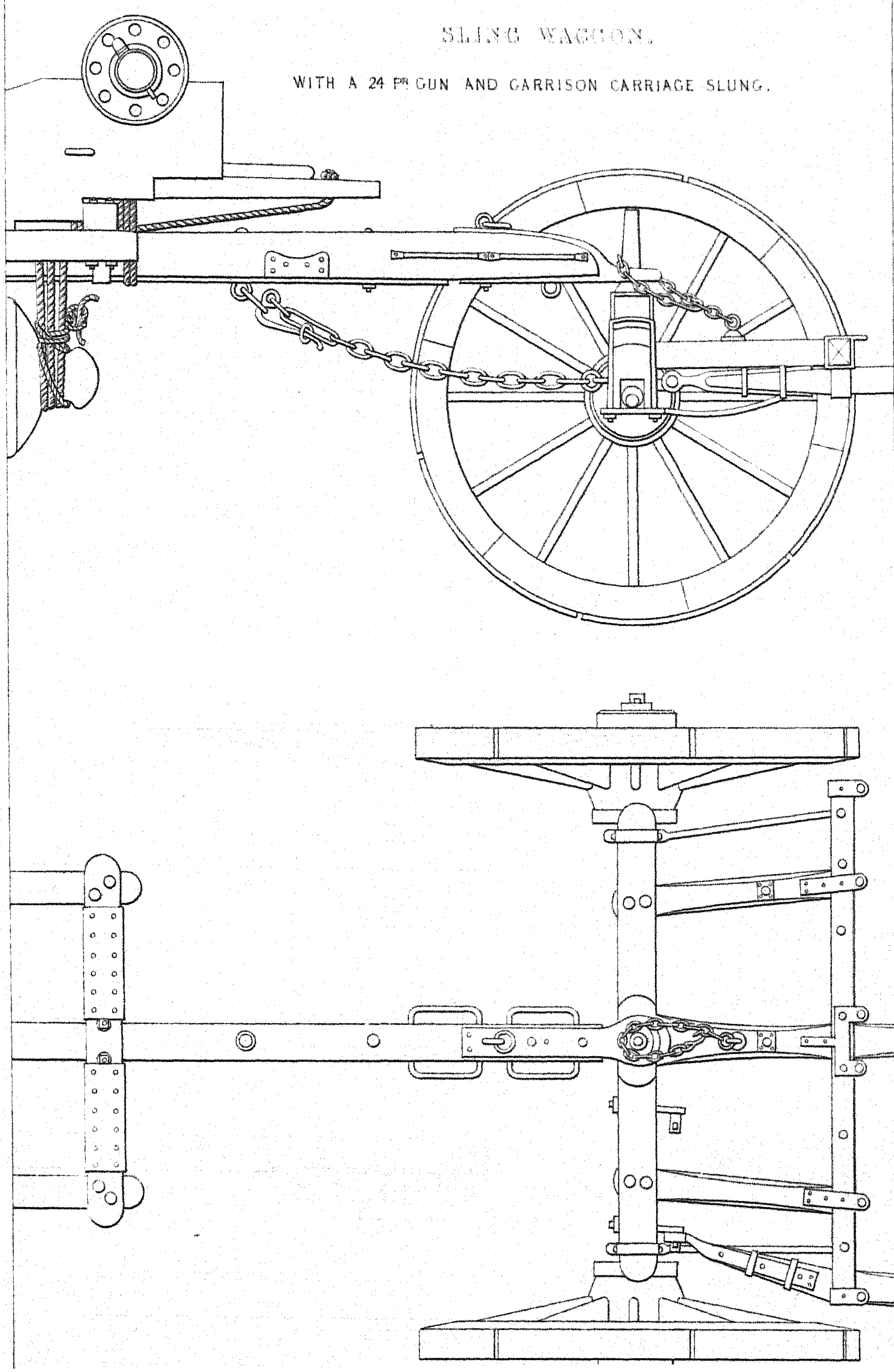
Inches 12 6 0 — 0 1 2 3 4 5 6 7 8 9 10 11 *Feet*

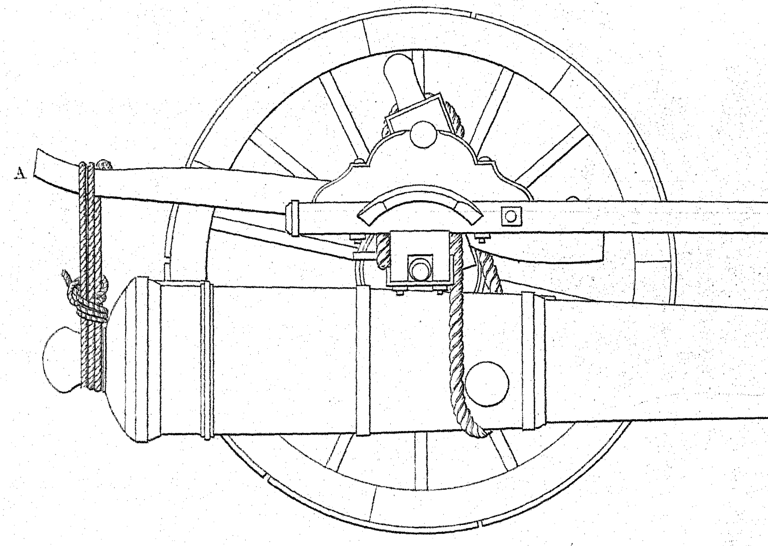


a
a Stoolbed
Entire length from A to Points of Shafts 24 Ft. 6 In.
A
1
2
3
4
5
6
7
8 Ft.

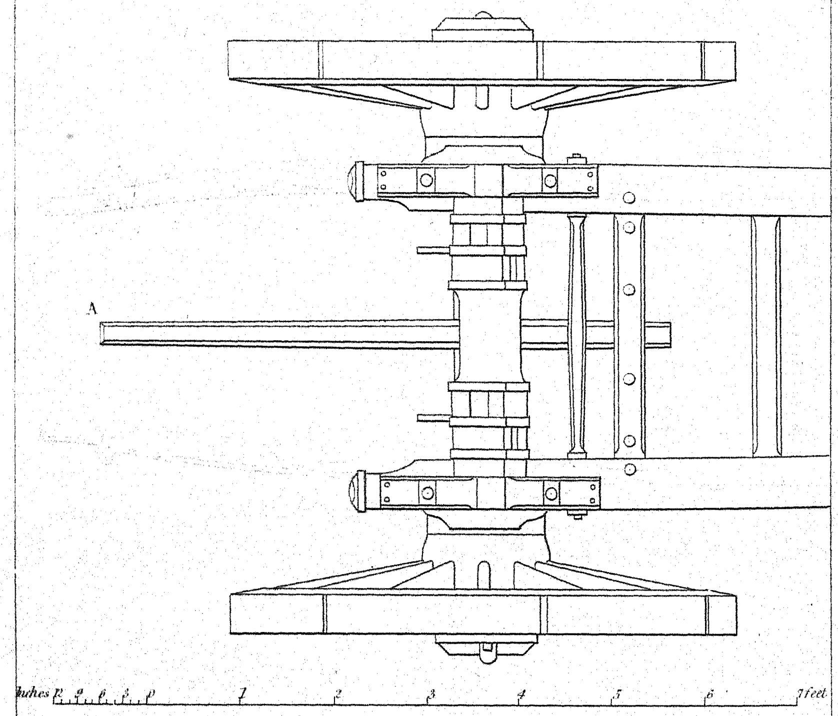
SLING WAGGON.

WITH A 24 P^R. GUN AND GARRISON CARRIAGE SLUNG.



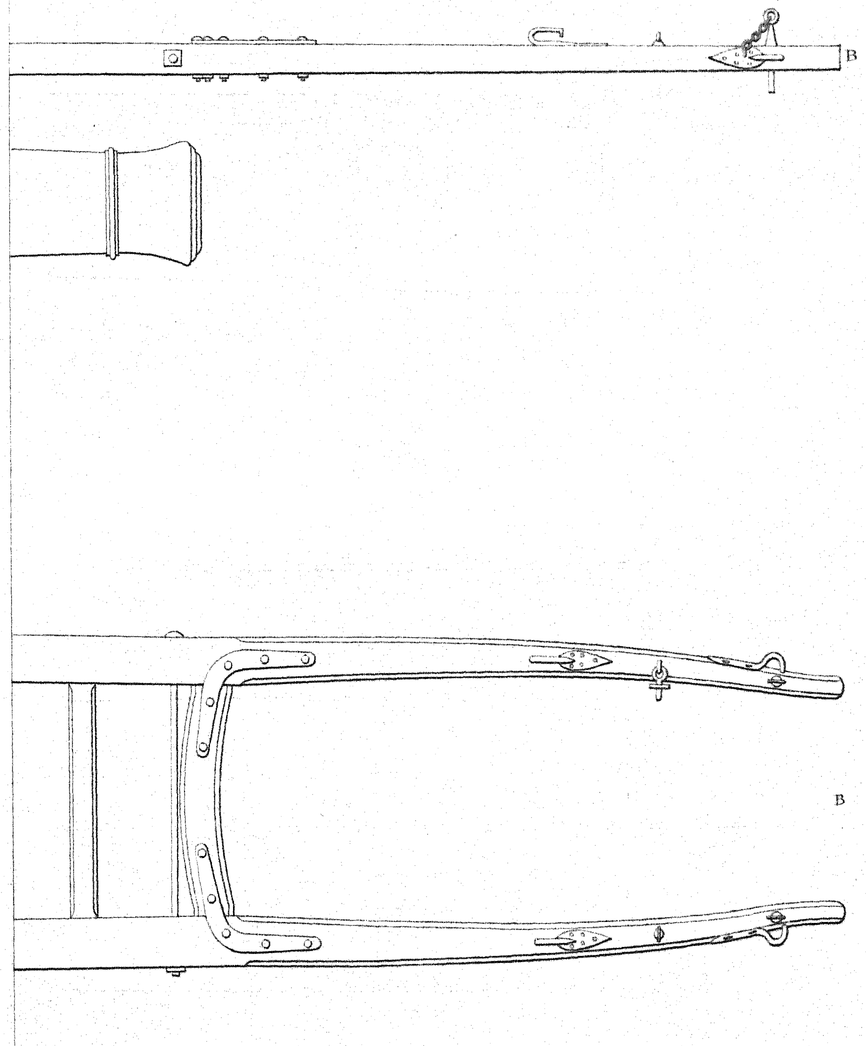


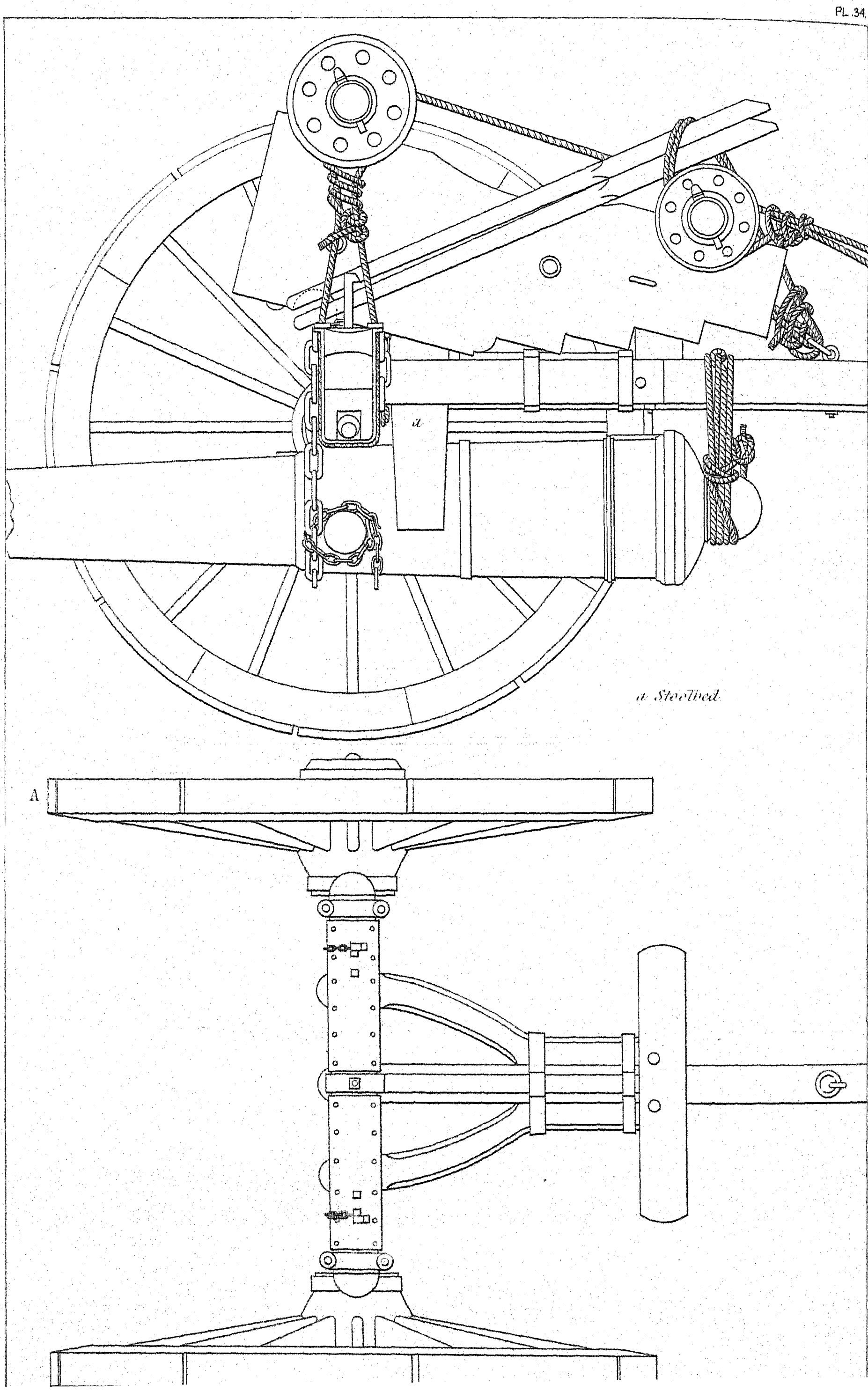
Entire length A B 17 feet.



SLING CART.

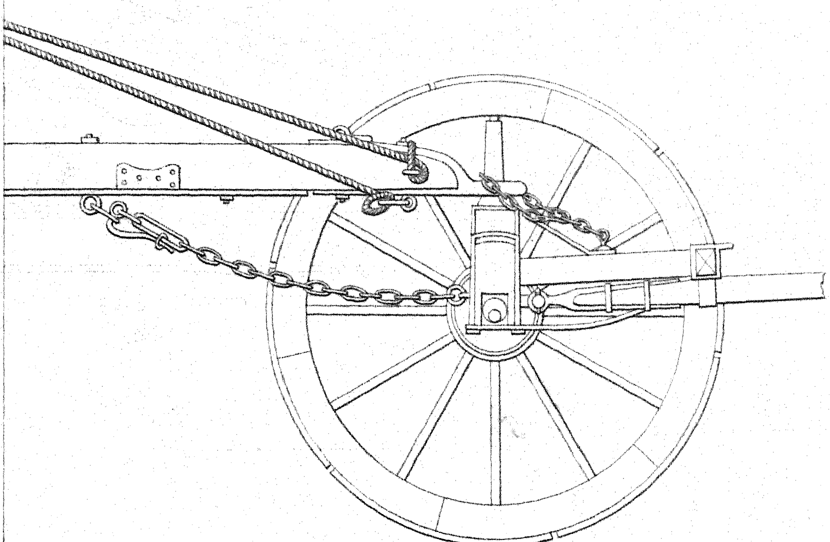
WITH A 24 P^R GUN SLUNG.



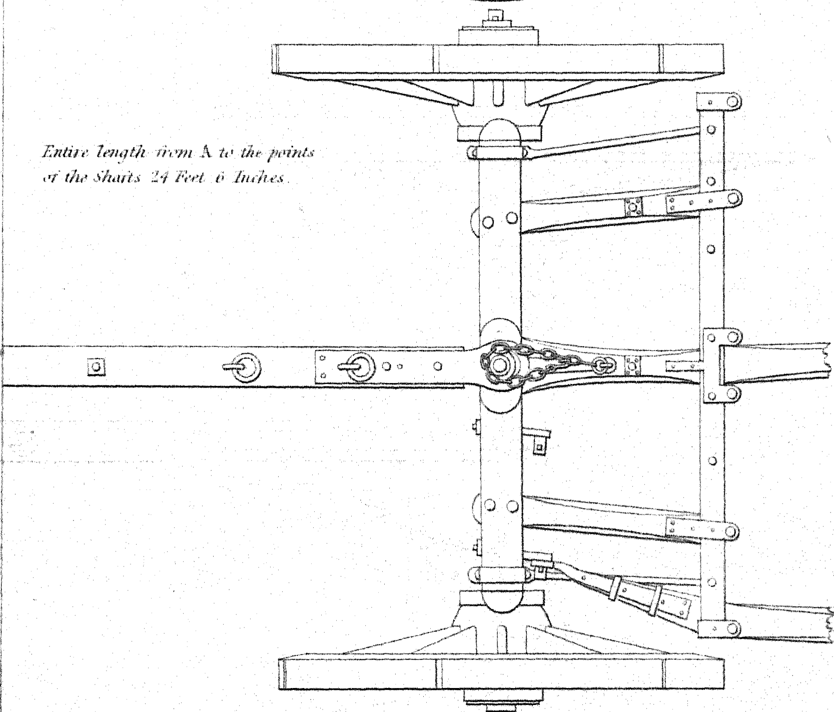

a
a Steelbed.
A

DEVIL CARRIAGE

WITH A 24 PR GUN & GARRISON CARRIAGE SLUNG.

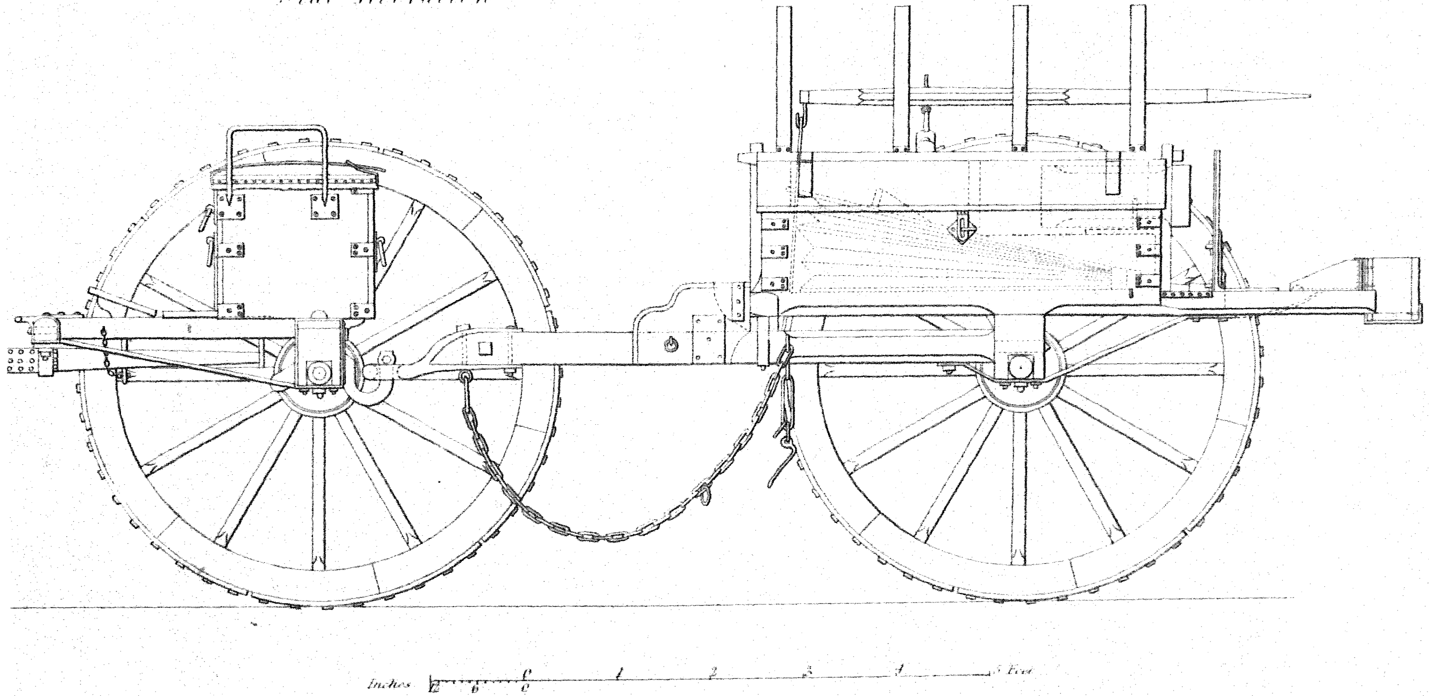


Entire length from A to the points of the Shafts 24 Feet 6 Inches.



FORGE WAGGON.

Side Elevation



FORGE WAGGON.

Plan

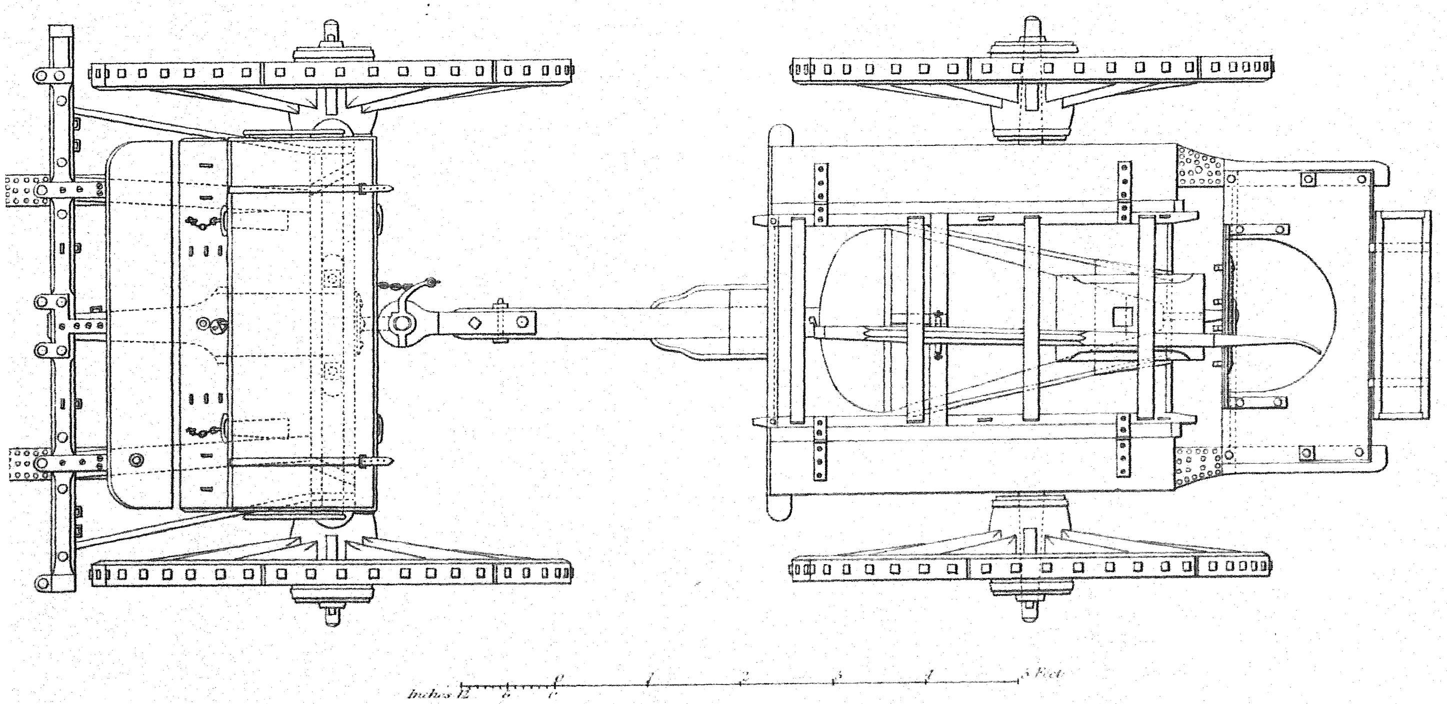


TABLE XVIII.

CONTENTS OF A FORGE WAGGON.*

Vide Plates XXXV. XXXVI.

Bellows, pairs		1
Anvil, with block		1
Coals, bushels		2
SMITHS' TOOLS IN THE LIMBER.		
Tongs, pairs		2
Slices		1
Ladles		1
Vices	Standing	1
	Hand	1
Shoeing Smiths' tools, sets		1
Jobbing Smiths' do. do.		1
Small Medicine Chest, for Farriers' use		1
Hammers	Sledge	1
	Hand	1
	Riveting	1
Cold Chisels	Rod	2
	Hand	2
Punches	Rod	2
	Hand	2
Screw-drivers		1
Rasps	½-round	6
	Round	6
	Flat	6
	3-square	6

CASK.—*Vide* 'BRIDGE, CASK.'

CASTRAMETATION is the art of laying out Camps, whether the troops intended to occupy them are to be hutted, under canvass, or bivouacked.

Encampments on actual service may be divided into *Camps of Position*, and *Incidental Camps* taken up every night on a march by troops traversing a country where an enemy may be met with. There are also, in time of peace, *Camps of Instruction or Exercise;* but under any circumstances, and whether the troops are hutted, under canvass, or bivouacked, the principles here mentioned should be attended to. Troops are however seldom *hutted*, except in Camps of Position.

The situation selected for a Camp should be healthy, not liable to be flooded, well provided with water, and should have abundant supplies of wood and forage close at hand: also, if the troops are on actual service, it must be capable of defence, and should not be overlooked. The British Army generally encamps by brigades, or divisions, independently. The troops of each arm should be encamped in lines parallel to the probable line of battle, and in such a manner, that all may form line directly in front of their Camp without confusion, by night as well as by day, and act efficiently; the Infantry, if the country is open, being placed so as to be protected by the Cavalry; and, if the country is close, so as to cover the latter, whilst the Artillery should occupy the most commanding positions, (if possible, so as to flank the front of the Camp,) and should be duly supported by Infantry and Cavalry.

The flanks of the Camp should be, if possible, protected by a village or river, and care should be taken that the prolongation of the lines may fall upon ground whence they cannot be enfiladed, and that the ground in front is favourable for a field of battle.

The Camp of each regiment, brigade, or division, should occupy the same space in front which it would cover when drawn up in order of battle, (calculating upon the effectives only,) and there should be ample space in front for manœuvring, and intervals of about 400 yards between the fronts of the first and second lines and reserve,

* From Spearman's 'British Gunner.'

when several corps or divisions are together: the interval between the flanks of battalions, or between those of brigades, may be taken at about a Company's length.

The reserve should be placed so as to protect the approaches to the rear, and also to be capable of quickly affording aid to any of the troops in front.

The communications throughout the Camp, across its front, and from every part of it to the front and rear, must be rendered easy,—the lines of retreat being decided upon in the first instance.

Fuel and water are amongst the most necessary items, and their importance will justify the choice of an otherwise inferior position.

The rivulets near the Camp should be dammed across at intervals, to retain the water for the supply of the troops, and at as early a period as possible. Where the quantity is limited, an active police must be established, to see that the ponds are not drained for fish;—that cattle have not unrestrained access to it;—that horses are not watered *in* it;—and that the men do not bathe, and that clothes are not washed, in the upper portions. If the river is only to be reached at points under the control of the enemy, they must be either covered or supported by field-works; or the water must be led to reservoirs in the rear; and possibly diverted in its entire course.

A chain of guards must be established round the Camp on those points which command the approaches, but not so as to be out of sight; and sentries must be posted, so as not only to prevent the approach of an enemy, but the egress of the troops for the purpose of plundering, &c.

The several Parks should be established about 200 yards in rear of the Camp, and remote from houses, so as to lessen the chance of danger from fire; the carriages must be placed so that any of them may be easily moved at any time to the lines of retreat or advance. P. B.*

The details of laying out Camps for Cavalry, Infantry, and Artillery, are given in figs. 1, 2, 3, respectively. Cavalry rarely encamped during the late war,—but fig. 1 is taken from a Horse-Guards' document, modified to the present circumstances of the Service. Fig. 2 gives the practice as now established for troops in Ireland: in forming from Line for a Regimental Camp, the battalion being in open column of divisions,—

Grenadiers and Light Infantry stand fast.	No. 2 closes on No. 1.	The companies of the right wing which move, close to the front; those of the left wing, to the rear.
	4 ,, 3.	
	5 ,, 6.	
	7 ,, 8.	
		Nos. 2, 4, 6, 8, and Light Company, counter-march.

The encampment of the 9-pr. Field Battery allows for 164 horses, as well as for the total number of Gunners and Drivers necessary,—on the Cavalry footing of 12 men per tent.

In figs. 1, 2, no arrangements are made for Sutlers, Bâtmen, and Privies; they may be arranged in the rear, according to circumstances, provided always that they lie within the rear guard.

During the latter part of the Peninsular War, the general issue of tents to the Portuguese troops was discontinued; instead of these, their blankets were edged with cord, looped at the corners; and with a squad of four men, these blankets could be thus secured to their muskets, crossed, so as to form a small ridge tent.

* Thus far by Lieut. Bainbrigge, R.E., whose being sent abroad prevented his completing the Paper.

Table of Marquees and Tents for the General Service of the Army.

Description of Tent or Marquee.	No. Men for.	Extreme space inside pins.		Weight, &c. lbs. Dry.	lbs. Wet.	No. Pins. Small.	No. Pins. Large.	Packed in	Tonnage.	Remarks.
		ft. ft.							cub. ft.	
Common circular (or Bell) Tent.	12 Cav. or 15 Inf.	17 diam.	Tent Poles	$56\frac{1}{4}$ $9\frac{1}{4}$	92 11	42	,,	V.	5	It is probable that this weight may be somewhat reduced by-and-bye; the additional weight arises from an improvement in the canvass. Four of these Tents are allowed for each Regiment, as Guard Tents.
			Total	$65\frac{1}{2}$	103					
Marquee, large. Field Officer or Captain: with Ticken lining.	1	35×28	T. P.	140 33	210 34	96	4	V.	12	Not allowed to Cavalry and Infantry of the Line: but they are issued for Artillery purposes occasionally.
				173	244					
Marquee, small. Subaltern: with Ticken lining.	2	31×24	T. P.	117 33	186 34	76	4	V.	11	Do. do. do.
				150	220					
Laboratory Tent. Large, circular.	,,	42 diam.	T. P.	169 83	290 85	96	4	V.	13	For Artillery purposes only.
				252	375					
Laboratory Tent. Small, circular.	,,	39 diam.	T. P.	123 $33\frac{1}{2}$	187 $34\frac{1}{2}$	78	4	V.	$7\frac{1}{2}$	Do. do. Formerly called a Mess-Tent.
				$156\frac{1}{2}$	$221\frac{1}{2}$					
Ridge Tent.	2	8×8	T. P.	20 8	30 $8\frac{1}{4}$	14	,,	B.	$1\frac{1}{2}$	
				28	$38\frac{1}{4}$					
Hospital Marquee.	,,	47×34	T. P.	346 82	560 84	180	4	V.	26	1 per regiment allowed.
				428	644					

Two mallets allowed for every description of Marquee or Tent. V (in ninth column) signifies packed in a canvass valise; B in a bag.

HUTTING.

For Winter, or other Standing Cantonments, when towns or villages are not to be had,—Huts should be made. These have every shape, size, and quality; from the open screen of the Hottentot,*—the roof-shaped Gypsey straw shed,—or the lowest Irish turf sheeling,†—to the cottage built of stone set in clay,—of raw brick,—of cob,—or of 'wattle-and-dab.'

In making cob, straw is trampled into the clay, and the walls carried up in thin courses laid on in small shovelfuls at a time, within two planks on edge as a mould, shifted upwards as the work rises. Less than 12 inches thick of this is musket-proof. In constructing wattle-and-dab houses, there is first a plain frame-work for the walls of upright poles fixed in the ground, and held together above by a wall-plate; the corner and door-posts being stronger than the rest. The poles for the walls may be about 18 inches apart, and are wattled with rods so as to support the clay, which must be worked in by hand on both sides at once,—the first coat being left rough to allow a hold for the second. To give stiffness to the framing, diagonal bracing might be fixed to the walls inside; also across the corners of the wall-plates as dragon-ties. The floor, of well-rammed clay (mixed with cow-dung) and gravel, high enough above the ground to keep it dry. The fire-place and chimney, in all cases, of stone or brick, and best run up in a gable. The thatch of the roof supported on rough slight rafters. The whole, whitewashed, inside and out; and a gutter run all round at a little distance outside.

Those who are unacquainted with the virtues of cow-dung will be surprised to find how a clay-floor is improved by being washed daily with a very thin mixture of it and water, which is perfectly inoffensive. Cow-dung also gives great toughness to the clay on the walls: it is for the like reason used in pargetting.

A great protection against fire may be given by thickly coating the thatch of the roof with whitewash, or rather, very thin mortar.

Without departing from the principle of the length of the front being equal to that of the troops in line,—such an encampment may be arranged so that the huts may support each other by a flanking fire, especially from the Officers' quarters and the Guard-houses.

From the probable scarcity of suitable timber, the huts for the men may be only wide enough for one row of beds: a quarter for fifteen men, at 1 pace per man, will thus be 37′ 6″ × 9′ in the clear, which, in a cold climate, will require a fire-place at each end. If, however, timber can be obtained, it will be better to make the barracks 20 feet wide, there being no objection to a row of posts down the middle supporting the tie-beams, if necessary.

The following extracts from the Orders of the Light Division, by Major-General Robert Crawford, between 1809 and 1811, and from the Queen's Regulations, are given in reference to the chief points in the routine, and associated duties, of Encampment.—The former are marked by an asterisk.

* As a standing order, when circumstances permit, each regiment will be preceded by two Officers, for the purpose of taking up quarters; one of them will march 24 hours before the regiment, and on his arrival will receive the necessary in-

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* Screens of interwoven branches to windward of the bivouac fire; these give great protection from all weather except a downright vertical heavy rain: if they are earthed up for a foot or two above the ground, outside, so much the better.

† Two triangular dry stone wall gables; rough pole rafters resting on the ground, and covered in with sheets of turf: a North-American Indian would use sheets of birch-bark.

formation from the Assistant Quarter-Master-General, or from the Quarter-Master of the regiment preceding that to which he belongs. The other Officer will march the same day as the regiment does, but sufficiently early to arrive at 10 A.M., when he will have the quarters pointed out to him by the Officer who went on the day before, and who, after having done this, will proceed to the next station.

* The Camp-colour Men, viz., one per company, under the command of the Quarter-Master-Serjeant of each regiment, and one Officer for the column, will assemble at the Assistant Adjutant-General's quarters every morning on the sounding of the first bugle; viz., $1\frac{1}{2}$ hour before the hour appointed for the march of the brigade.

* The Officer in charge of these parties will march them in perfect order, and as expeditiously as possible, to the next station, where he will find the Officer gone forward with the Assistant Quarter-Master-General; and after marking out the quarters of each company, he will take care that each party shall remain together until the regiment arrives.

* The Quarter-Masters will, when practicable, march 2 or 3 hours before the brigade; or, if possible, the preceding evening; and as soon as they arrive, they will proceed to purchase the provisions, forage, &c., for their respective corps.

* When regiments march separately, the Quarter-Master-Serjeants must be sent forward for the above purpose.

* One of the first duties of Officers commanding regiments on arrival in Camp, or Quarters, is to cause the communication from the position or quarters of the regiment to all the principal roads by which the brigade may possibly march, to be thoroughly examined, and all obstacles removed, in order that each regiment, without the assistance of a guide, and without delay, may be able to move in the night, if required, to whatever road in the vicinity of the Camp or Quarters may be pointed out for the assembly of the brigade.

* On entering Camp or Quarters, each regiment must form on the same ground which it is to assemble upon in case of alarm; and when formed, the ranks are to be opened.

* If the companies have to form up in succession, each will slope arms and open ranks as soon as formed by words of command from its own Officer; but they must not order arms, or stand at ease, until directed to do so by the Commanding Officer of the regiment, which will not be done until the whole corps is formed.

* After the reports are collected as ordered (in a preceding Article), the men may be allowed to sit down, or walk about behind the ground of formation, which will be marked out by a sentry on the right flank of each company; but they must not be allowed to go 10 yards from the spot until the guards and pickets are placed, and all the other necessary arrangements are made; unless it rains hard, in which case the men (except those for duty) may be dismissed as soon as the reports are collected; but no state of weather, nor any other circumstance, is to prevent the corps being kept under arms until the reports of the absentees are regularly collected.

* As soon as the corps are formed, and the reports collected, the guards must be placed, and the men or companies warned for in or out-lying pickets.

On the arrival of a brigade or battalion on the ground destined for its Camp, the Quarter, and Rear Guards, of the respective regiments will immediately mount; and when circumstances require them, the advanced pickets will be posted. The grand guards of Cavalry will be formed, and the horses picketed.

The men's tents will then be pitched; and until this duty is completed, the Officers are, on no account, to quit their troops or companies, or to employ any soldier for their own accommodation.

The troops must at all times be kept in the most perfect readiness to turn out, and it is expected that in half an hour from the time they receive the order to march, either in the night or day, the army shall stand at the head of its encampment; that the baggage shall be packed, and the whole prepared to move. This state of preparation is equally as essential in Cantonment as in Camp; and in both, the troops must be accustomed to march without any previous notice.

Movements of troops, or dispositions of march, will not always be put in orders, but will be delivered to such persons only as they concern, &c.

On arriving at a Camp which is intersected by hedges, ditches, unequal or boggy ground, regiments will immediately make openings of communication 60 feet in width.

The ground in front of an encampment is to be cleared, and every obstacle to the movement of the artillery and troops is to be removed.

Commanding Officers of regiments must take care that their communications with the nearest great routes are open and free from any impediments.

* In Camp, the best water will be pointed out before the men are dismissed, and the necessary directions for opening communications given.

* The places for cooking in Camp must be pointed out to the Orderly Serjeants of companies by the Captain of the day; and must be particularly chosen, with a view to avoid danger of fire; and for the greater facility of superintending, all the companies must cook as near as possible together.

Whenever a regiment remains more than one night in a Camp, regular kitchens are to be constructed.

Necessaries are to be made in the most convenient situations, and the utmost attention is required in this and every other particular to the cleanliness of the Camp. If circumstances will allow the ground on which a regiment is to encamp to be previously ascertained, the Pioneers should make these and other essential conveniences before the corps arrives at its encampment.

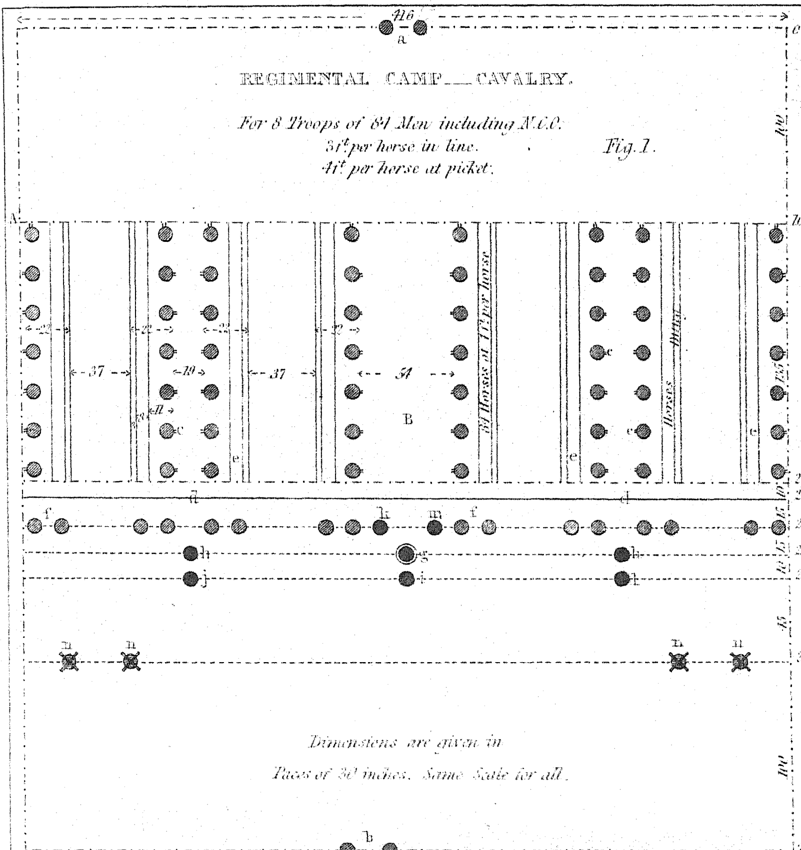
* It must be explained to the men as a Standing Order, that when no regular necessaries are made, nor any particular spot pointed out for easing themselves, they are to go to the rear at least 200 yards beyond the sentries of the Rear-Guard: all men disobeying this order must be punished.

It is the duty of the Quarter-Master of the day of the brigade to attend to the cleanliness of the Camp, take care that all broken glass, and filth of every kind, are removed, for which the Quarter-Master of each regiment is responsible, as far as the Camp of his regiment is concerned.

* If the arms are not piled on the ground of formation, a stake must be fixed, or some other conspicuous mark must be made on the right and left flank of the ground on which each company when called out is to form.

* In towns and villages, the Alarm post will be fixed, and the disposition made for the defence of that portion of the circumference falling within the district of the regiment; and all other necessary directions will be given by Officers commanding regiments, and the distribution of billets made by those commanding companies, before the men are dismissed.

* Officers must always occupy a part of one or more of the houses allotted to their respective companies.



p Drums &c.
A Magistral Line.
B Adjutant's Parade.

k Orderly Officer.
l Quarter Master.
m Adjutant.
n Kitchen.
o Arms.

f Troop or Compy Officer.
g Commanding Officer.
h Field Officer.
i Surgeon.
j Paymaster.

a Quarter Guard.
b Rear Guard.
c Men.
d Officers Horses.
e Troop Horses.

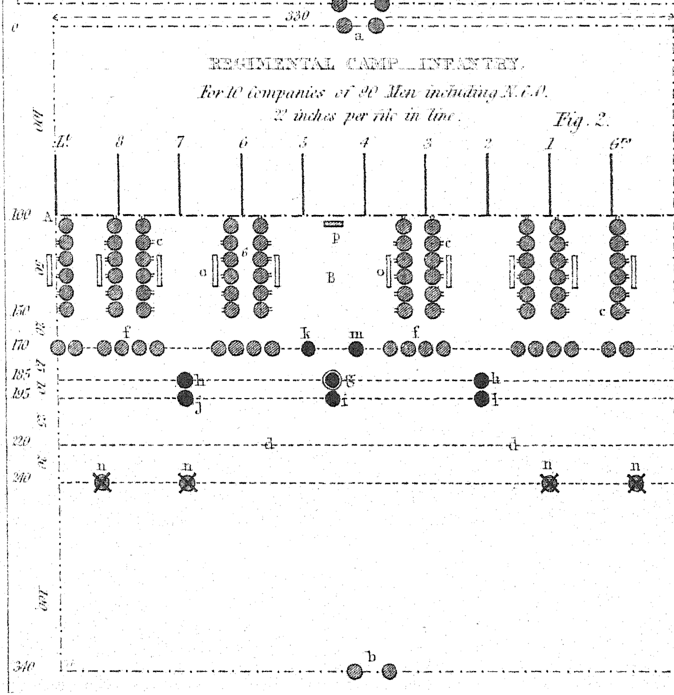
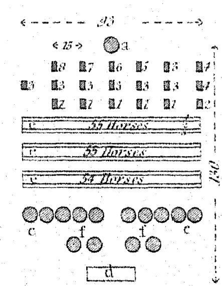


Fig. 3.

ARTILLERY

9 Pr Field Battery.



1 Guns.
2 Howitzer
3 Gun Ammunition.
4 Howitzer Do.
5 Spare Wheel Carriage.
6 Forge Waggon.
7 Store Waggon.
8 Store Cart.
e { 1 Harness. 2 Horses. 3 Dung.

OUTPOSTS.

"As soon as an Officer commanding an outpost or advanced picket (whether of Infantry or Cavalry) arrives on his ground, he must endeavour to make himself master of his situation, by carefully examining not only the space he actually occupies, but the heights within musket-shot; the roads or paths leading to or near the post, ascertaining their breadth and practicability for Cavalry and Artillery; to insure a ready and constant communication with the adjoining posts and videttes, in the day by signals; in the night by patrols. He should examine the hollow ways that cover the approach of an enemy, and consider all the points from which he is most likely to be attacked. He will by these means be enabled to take measures to prevent surprise; and should he be attacked during the night, from the previous knowledge he has of the ground he will at once form a just estimate of the nature of the attack, and make his arrangements for defence with promptitude and decision.

"An intelligent Officer upon an outpost, even unprovided with intrenching tools, will materially strengthen his post, when the unobserver would remain inactive. A tree felled with judgment, brushwood cut to a certain height, pointed stakes about breast high placed on the point most assailable to an enemy, may be attended with the greatest advantages, and can be effected with the common hatchets or bill-hooks, with which the soldiers are provided for the purpose of cutting fire-wood.

"Nothing checks the ardour of troops more than an unexpected obstacle within point-blank musket-shot of the place attacked: this must not be overlooked by an Officer who defends; and no obstacle he can throw in the enemy's way at that distance from his post must be deemed unworthy of his attention.

"At night, or in thick weather, the videttes, or sentinels, on outposts are to be doubled." R. J. N.

CHAIN.—*Vide* 'CABLE, CHAIN.'

CHEVAUX-DE-FRIZE.

Ordinary pattern, of wood,—square barrel.

Barrel.—Length,	9′ 6″.	Breadth and Depth, $3\frac{1}{2}$″.	Weight,	35 lbs.
Spears (20) „	6′ 0″.	Diameter of Bundle, $7\frac{1}{2}$″.	„	61 „
		Total . . .		96 „

Each spear is $1\frac{1}{4}$″ diameter, with a plain square iron point, and a stud in the middle of the length to lock inside the barrel-plate.

The barrel is secured at each end by an iron band, 3″ broad × $\frac{1}{8}$″ thick, through which the outer spear passes, and to which the T & O keying-chains are fixed. Each spear-hole is guarded by an iron plate (on one side of the barrel only) $3\frac{1}{2}$″ × 3″ × $\frac{1}{8}$″, with a notch in the edge of the circular hole to allow the spear-stud to pass and lock. The spears are made of ash, and the barrel of Memel fir.

New pattern, of iron,—cylindrical barrel; the whole consisting of tubes, the spears (twelve in number) being plugged at the ends with points; and packing away inside the barrel.

Barrel.—Length,	6′ 0″.	Diameter, exterior, $4\frac{3}{4}$″. „ interior, $3\frac{7}{8}$″.	Weight,	22 lbs.
Spears (12) „	4′ $7\frac{1}{2}$″.	Diameter of each, $\frac{7}{8}$″.	„	43 „
		Total . . .		65 „

The wooden pattern has the advantage of being somewhat lighter, the length of 9′ 6″ in both being 96 and 103 lbs., wood and iron, respectively. It is more easily replaced and repaired, and the length of 9′ 6″ renders it more available as a barrier or temporary gate for closing openings through which carriages are to pass, than the 6′ of the iron pattern; which last has the advantage of great portability in reference to bulk. R. J. N.

CHRONOMETER.—*Vide* 'Observatory.'

CIRCLE, REPEATING.—*Vide* 'Observatory.'

COMBUSTION, SPONTANEOUS.

Few or no chemical combinations can take place without a disturbance in the equilibrium of caloric in the substances to be so combined; and when caloric is thereby evolved in sufficient extent and rapidity, and when one or all the bodies engaged may be freely combustible, ignition takes place. When this is unintentional, or is the result of ignorance or carelessness, it is convenient to call it *Spontaneous* Combustion.

Thus we frequently hear of hay-ricks, &c., on fire; or occasionally of carts loaded with quick-lime being burned by the rain falling upon it. There are also somewhat apocryphal accounts of coal in coal-yards being destroyed in like manner. But the most important instance of this class, as far as regards the preservation of Government establishments, is the combustion that infallibly and rapidly ensues when greasy hemp, flax, or cotton, is allowed to remain loosely heaped together, in any quantity, in a confined unventilated space.

Full proof of this has been made by experiment in the Dockyards; and there is much reason to attribute many fires in former days to carelessness in the rope-walks and hemp stores; in consequence of which, rigorous orders have been of late years issued as to the immediate disposal of loose oakum and hemp sweepings—all more or less greased or oiled. The very oil-rags used by Engravers in cleaning plates, when heaped together to any amount, will be consumed in a few hours.

The combination in question seems to be between the oil and the oxygen of the atmosphere. Oil has always an affinity for oxygen; though, when the bulk of the former is considerable in proportion to the surface, the action is but feeble, and the results not ordinarily appreciable: but, in the case of admixture of such fibrous vegetable bodies as hemp, flax, or cotton with oily matters, where the ratio of surface to solidity is great, and when the conditions for accumulating heat are favourable,*—this accumulation soon produces ignition amongst such inflammable bodies as those just enumerated. R. J. N.

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* Flax, &c., and the air amongst the loose fibres, are both imperfect conductors of heat; also, the space being assumed to be confined, there are no passing currents of air to reduce the temperature.

COMMAND.*

"Every one must have observed, that there exists amongst all classes of men a sort of vague and general impression, that missiles, projected from elevated situations, have a more destructive and more irresistible effect than when projected from an equal level; yet no one can doubt that Artillery, firing from an elevated situation, is less destructive to bodies of troops than when firing on the same level, in consequence of its great plunge, which scarcely admits of one shot killing more than a file or two; whereas a horizontal discharge frequently sweeps or bounds through a whole column.

"With respect, however, to the effect of Artillery firing from a height on a besieger's approaches, there is little accordance of opinion even amongst professional men, and probably for this reason, that it is almost entirely dependent on distance.

"Thus, for instance, a battery of 24-pounders, placed on an elevation of 100 or 120 feet, though firing down on a trench at the distance of 700 or 800 yards, requires an elevation of 1 or 1¼ degrees above its crest to reach it; and the same guns firing at a trench on an equal level at the same distance, require scarcely more elevation above it; so that the difference of the curve formed by the shot, at the instant of striking the trench from either situation, is almost imperceptible; and the force of the shot being in both cases the same, no other cause can be assigned why the action of the one should be more destructive than that of the other.

"It is, however, very different with the same guns when firing from a similar height, of 100 or 120 feet, at a battery or trench only 300, 400, or 500 yards distant; as the guns being then fired directly down on the work, the shot frequently strikes near the interior edge of the parapet with its greatest force, and passing through 4 or 5 feet of the interior revetment, renders every part of the battery insecure.

"The deduction is, that guns firing from a height on a besieger's approaches, unless the height be within 400 or 500 yards, are less destructive than similar guns firing à ricochet on an equal level.

"Height of situation invariably gives a more destructive effect to musketry on the approaches, as its use implies close approximation, in which case it is nearly impossible to raise the parapet of a trench or sap sufficiently to cover more than a very small breadth of its surface.

"In the attack of a mountain fortress, the effect of a direct fire does not seem to be materially diminished by the height of the defences.

"Height of situation is even likely to offer a facility for reducing small posts by means of the Miner.

"Works on heights, however, when properly constructed, have the excellent defensive property of more effectually covering their scarps, palisades, and defenders, than works on a plain; and, when the rise of the height is very rapid, it utterly precludes the formation and use of batteries à ricochet; besides which, their glacis necessarily terminating in a very sharp angle at its crest, occasions an enormous labour to the besiegers to form a sufficient base on which to place their breaching batteries.

"It should, however, be mentioned, as some counterbalance to these advantages, that a height of one continuous and rapid ascent gives a facility to a besieger for pushing forward his approaches, because, on an inclined plane, less height of parapet gives cover in the Sap than when formed on an horizontal base; and the guns of works on

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* Abridged from 'Sieges in Spain,' by Major-General Sir J. T. Jones, R.E. Second edition.

steep heights can seldom be sufficiently depressed to fire on the trenches, and the progress of the Sap can only be opposed by musketry or vertical discharges.

"To carry approaches from a height against a work situated on a parallel height, having a valley between them, is attended with considerable difficulties; for, if the side of the hill to be descended be very steep, no practicable depth of trench or height of parapet will give cover to the troops, unless each return of the approaches be directed very much clear of the salients of the work under attack, which increases considerably the length of each return, and consequently the labour of forming it; and, even after this additional labour, the ordnance next the salients of the besieged place, which take the approach en écharpe, have a murderous effect.

"The depth required to obtain cover will, of course, be greater or less in descending equal slopes, according to the relative height of the ground to be opened for the approach and of the enemy's work.

"Another inconvenience, incident to carrying approaches down very deep declivities, is that the rear of the trench is higher than the parapet in front, and many howitzer shells, fired à ricochet, which miss the former, are stopped by the latter, and fall into the trench; and frequently, shells from mortars, pitched beyond the trench, roll back into it, in consequence of the steepness of the face of the hill.

"It is apparent that as the approaches nearly reach the bottom of the valley, these evils increase, and that all the advantages of defence to be drawn from height of situation, operate against the besieger's trenches in a ratio according to the steepness of the descent and the relative height of the sides of the valley; therefore any plan of operations, which necessitates carrying the approaches across a valley for the attack of a work on the opposite side, should, if possible, be avoided.

"From these various counterbalancing properties, resulting from height of situation, it may be concluded, that a fortress is not to be pronounced of great strength from the circumstance of elevated situation alone; for, even to form a moderately just opinion of its strength, it must be ascertained that its walls are all covered from distant batteries, that its interior be casemated, that the face of the height be under fire of the ramparts, or, if precipitous, that it be flanked on every point. If such, however, be found the case, height of situation must be considered to add greatly to the defensive powers of a place, and demands our respect.

CONSIDERATIONS ON THE DISADVANTAGES ACCRUING TO A PLACE FROM BEING COMMANDED.

"Having endeavoured to discuss the real value of height of situation as a defensive quality, it may not be amiss to endeavour to ascertain the amount of the ill arising from its reverse, or a place being situated lower than the hills without it; and to inquire if it really be an evil of such magnitude as is generally supposed—the term 'commanded' being usually accepted as denoting every thing bad; and many Officers even carrying their feeling on this point so far as to believe that a very commanding height deprives a fortress of all powers of resistance.

"The most prominent disadvantages under which a fortress labours from being commanded are, that the defenders of the work, and the interior of the place, are seen and exposed to the direct fire of a besieger's artillery; that its escarps are also exposed to be battered in a certain degree lower down, according to the greater or less height of the hill which commands them; and that in the same degree, the range of the enemy's projectiles is increased.

"Considered abstractedly, to be seen is rather an inconvenience than a positive ill; and as projectiles are never used at sieges from situations requiring their utmost range, the prominent evils from being commanded reduce themselves to two,—the

greater exposure of the escarps, and the direct fire of a besieger's artillery on the garrison whilst defending the works, and on the works themselves and their armament. Now the point-blank range of a 24-pounder being under 600 yards, and as it will not batter with good effect at a greater distance than 800 or 1000 yards, it would seem that all command in front beyond the latter distance is nearly harmless, except from the inconvenience it occasions to the garrison of being seen.

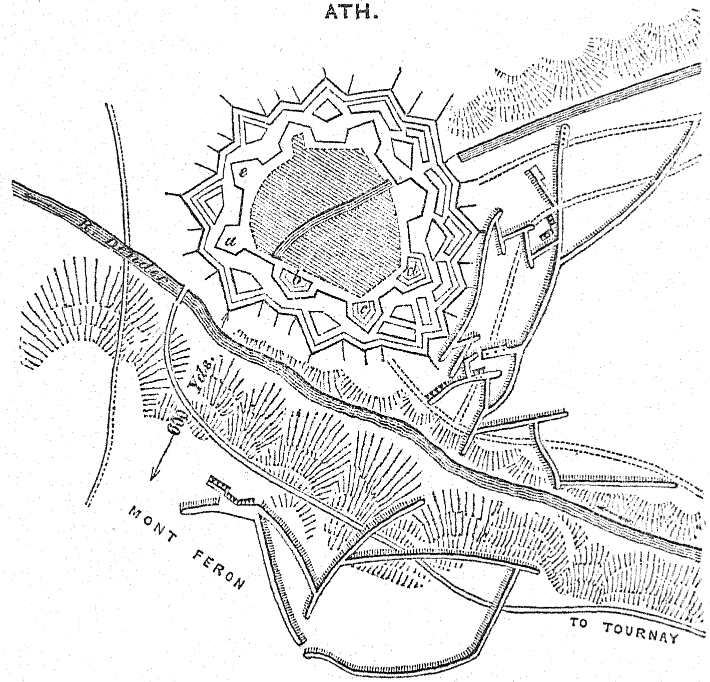
"Within the distance of 800 yards, being commanded, is, indisputably, a most serious detriment to a place, as its artillery may be dismounted, its defenders killed, its escarps laid open, and its buildings destroyed by a direct and accurate fire from the height; but the effects of such command may be greatly reduced, or even rendered null, by a just disposition of the works, and their relief. If a place be only commanded by one hill, and that of a moderate height, it requires no stretch of the imagination to comprehend, that if, instead of being built on a horizontal plane, as is customary, the works were constructed on a plane passing from some point in the interior, a few feet over the top of the hill commanding them, they would equally cover each other, and their parapets equally cover the defenders, as if the hill did not exist, and they had been built on a horizontal plane. Upon a similar principle, the exposure arising from the direct command of several moderate hills on the same front may be avoided; and even the works may be screened by the above method, and by the addition of traverses, parados, &c., from the command of such hills all around the place.

"But if the hills are of a great height, and near the place, the mischief arising from their command cannot be obviated by defilement; and even in many cases where it is possible to effect this defilement, the great labour and expense of so doing put it out of the question. Under such circumstances, the best resources are casemates and countermines, or to occupy the summits of the commanding hills by works of sufficient strength to restore the equilibrium of defence.

"There remains a disadvantage still to be mentioned accruing to a place from being commanded, which is, that a besieger's first batteries, placed on the height which commands it, may remain open till the last moment of the attack without incommoding his near approaches; but when the height falls rapidly in one continued plane to the glacis of the place, this advantage is much counterbalanced by the difficulty mentioned before, of carrying the approaches down hill; and should the fall of the ground be gradual, it will frequently happen that the fire of the batteries on the height will prove almost as annoying to those in the advanced part of the trenches as to the defenders of the place.

"From these causes, command is far more prejudicial to the defence of those works of a place, the general prolongation of which it intersects, than to the defence of those works to which it is parallel; even if the distance of the lateral command of such height be greater than that of its direct command. This may be exemplified by reference to the attacks of Ath, in 1697 and 1700, by those great masters of the art, Vauban and Marlborough, and subsequently by the Count de Clermont in 1745.

ATH.



"Two fronts of the enceinte of that fortress, *a*, *b*, *b*, *c*, are traced parallel to Mont Feron, which, at 600 yards distance, overtops their ramparts 75 feet, the interval being a regular slope to the foot of their scarps, and which no exertion of art has been able to screen from the direct fire of artillery from so domineering a point in their immediate front. Still, in neither attack, did those Officers avail themselves of batteries on this commanding height to breach the scarp walls of the fronts opposed to it, or for establishing a commanding fire to ruin their parapets, and then carry their approaches almost unopposed down the face of the hill to the counterscarp; but, on the contrary, establishing on the height powerful enfilading batteries to ricochet the collateral fronts, the prolongation of which the command of Mont Feron intersects, Vauban carried his approaches towards the front, *a*, *e*, to the right, and Marlborough his towards *c*, *d*, to the left; and to each, Ath fell an easy conquest.

"The Count de Clermont, in 1745, followed with equal success the path traced by the British General; so that it may safely be inferred from these examples, that the side of a place most closely commanded, when that command is direct, is not consequently the weakest.

"From the above statement it is apparent, that a fortress is not to be lightly and utterly condemned, because it may happen to be commanded; for if the heights commanding it be at a greater distance than 800 or 1000 yards, and do not enfilade any general line, they can have very little influence on the attack or defence. If the heights are not more distant than 600 yards, and on one side only, the effects of their command may have been parried by defilement; and by the same art, a certain degree of strength may have been given to a fortification when closely surrounded by moderate heights; and even where defilement has been impracticable, casemates, countermines, reverse batteries, and retrenchments, on the weakest fronts, may have more than compensated the general exposure. But, if on examination these precautions are found to

have been neglected, a fortress which is closely commanded by heights may safely be pronounced of little strength,—though there are innumerable instances in former, and some few in late wars, of such places having made good defences, from the intelligence of the Governor reserving the troops for the last stages of the defence, when the combatants become too closely in contact to admit of the interference of fire from distant batteries."

For *Relative* Command of Works, see 'Relief' in the Construction of Permanent and Field-works.

COMPASS, SCHMALCALDER'S.—*Vide* 'Topography.'

COMPASS, HARRIS'S MAGNETO-ELECTRIC.—The Inventor's object in the application of his discovery of the steadying action of the copper ring, "is the combination of great sensitiveness with stability and simplicity of construction; so that whilst the needle is free to obey the magnetic force of the earth in the most perfect way, it yet remains tranquil amidst the disturbing motions to which a ship is exposed: and this stability is obtained without the aid of friction or other mechanical impediment, which often produce an apparent steadiness, or rather sluggishness of the Compass (arising from indifference to motion), at the expense of accuracy.

"When the horizontal position of the card is disturbed by any alteration of dip incidental to a change of latitude, it is to be corrected by moving the silver sliders on the needle.

"Should the Compass be out of use, care must be taken to let the needle hang freely in the meridian; and if put into a store-room, or otherwise set by, the card and needle should be removed altogether, and placed with the needle downward in the shallow box provided for it,—the north point being on that part of the keeper marked with a cross, thus ×. A good compass is liable to deterioration and damage when stowed away without regard to its magnetic properties, and without due care being taken to preserve the agate and the point of suspension in a perfect state."

On the writer's own observation of this Compass, the needle was at rest in exactly one minute: it is stated to have been so in 45 seconds at other times. R. J. N.

CONTOURING.*

This term is applied to the outline of any figure, and consequently to that of any section of a solid body; but when used professionally in connection with the forms of ground, or of works of defence, the outline of a horizontal section of the ground, or works, is alone to be understood by it.

When the forms of ground or works are described by Contours, or horizontal sections, these sections are taken at some fixed vertical interval from each other, suited to the scale of the drawing, or to the subject in hand; and the distance of each, above or below some assumed plane of comparison, is given in figures at the most convenient places on the plan. When the scale of the drawing is about 100 feet to an inch, 2 or 3 feet will be found a convenient vertical interval between the Contours; and however large the scale of the plan, it will scarcely be found necessary to obtain Contours with a less vertical interval than 2 feet. If the scale of the plan be about 250 feet to an inch, or the ordinary special survey scale of 4 chains to an inch, 5 feet will prove a convenient vertical interval; and with a horizontal scale of from 500 to 800 feet per inch, 10 feet may be taken as the vertical interval. The French generally employ an imaginary

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* By Captain Harness, R.E.

plane of comparison above the highest points in the plan; but there does not appear to be any good reason why the figures, which would denote the altitudes of the several points of a plan above the level with which they are usually and naturally compared, should not be employed to denote the levels of the Contours. Near the coast, the level of low water, the plane of comparison for the soundings in nautical charts, is the natural plane of comparison for Contours; and the numbers affixed to them, when this is adopted, express their altitudes in the ordinary way.

Contours not only furnish a correct idea of the reliefs of the ground, &c., represented, but many problems can be worked by them without the aid of vertical sections: the following are the most useful:

The scale of a plane passing through three given points, A, B, C, (fig. 1), *may be found* by so dividing the line A C, joining the highest and lowest of the given points, that the two parts may bear the same proportion to each other, as the numbers expressing the difference of level between the third point and each of the other two; *i.e.* making $AD : DC :: A \backsim B : B \backsim C$; D will be on the same level as B, and B D will be a horizontal of the plane required.

To find the scale of a plane passing through two given points, and having a given inclination.—The inclination determines the interval in plan between the Contours passing through the two given points. With one of the points as a centre, and that interval as a radius, describe a circle; the tangent drawn to the circle from the other point is a horizontal of the plane required. If the distance between the points is less than the necessary interval between the Contours, this problem is impossible: when possible, it always admits of two solutions.

To find the scale of a plane passing through a given point, and parallel to a given plane.—It will agree in direction, and in its divisions, with that of the given plane; the numbers must be varied to correspond with the level of the given point.

To find in a plane, given by its scale of slope, as in fig. 2, *a line passing through a given point*, A, *and having a given inclination less than that of the plane.*—Trace a Contour of the plane having any convenient difference of level from the given point; with that point as a centre, and with the base due with the required inclination of the line, to the assumed difference of level as a radius, describe an arc cutting that Contour; a line drawn through either of the intersections and the given point will have the required inclination.

To find the intersection of two planes.—Produce, until they meet, two or more Contours, having corresponding levels of each; the line joining the points of meeting will be that of intersection. If the Contours of the two planes be parallel, their intersection will be known if one point in it be found; assume a third plane; mark its intersection with each of the others; the meeting of the two lines of intersection will be the point sought.

The intersection of the horizontals of any plane, with the Contours of a given surface at corresponding levels, shews, as in fig. 3, *what part of such surface rises above that plane.*

To find the plane passing through a given line and tangential to a given surface.—When the line is inclined, mark (producing it if necessary) the points having the same level as the Contours of the given surface, as in fig. 4, and draw from each of these points a tangent to the Contour on the same level with it; the tangent which forms the smallest angle with the lower part of the given line will be a horizontal of the plane. If the given line be horizontal, draw a tangent parallel to it to each Contour of the given surface; trace through any point in the given line, as in fig. 5, a line cutting the tangents drawn to the Contours of the surface; set off upon the given line, beginning from the same point, distances proportioned to the several differences of level between the line and each Contour (when the vertical interval is constant, this

is merely setting off equal parts); to these points of division apply the numbers of the several Contours, the first point assumed having the level of the given line; join each with the point where the line drawn cutting the several tangents intersects that having the corresponding level; the line making the smallest angle with the given line, on the side where the numbers apply to the lowest levels, meets the tangent through which the required plane must pass.

In tracing and surveying the Contours of ground, the following process may be adopted:—Complete the survey of the occupation of the ground, the streams, &c.; and determine carefully the altitudes of the trigonometrical points employed above the intended place of comparison. Take an accurate trace from the plot of one of the triangles, which, if the distances between the trigonometrical points are properly proportioned to the scale of the plan, will generally be a convenient piece in point of size to contour. Take this trace to the ground, and find upon the ground, and mark upon the trace, the points where each of the intended Contours will cut the boundary lines of the triangle.

Suppose the level of a trigonometrical point A (fig. 6) to be $273\frac{1}{2}$ feet, that the ground is falling towards B, and rising towards C, the third angle of the triangle: if the Contours are to be at 5-feet vertical intervals, 270 feet will be the level of the next below A, and 275 feet of the next above A; the surveyor therefore must find a point $3\frac{1}{2}$ feet lower than A on A B, and another $1\frac{1}{2}$ ft. higher than A on A C.

Put up a theodolite near A, and using it as a level, read the levelling staff when it is held at A; add $3\frac{1}{2}$ feet to this reading, and send the staff along the line A B until the vane agrees with the horizontal wire of the telescope; the point where the staff then stands will be $3\frac{1}{2}$ feet lower than A, and will be the intersection of the Contour at the level 270 with the line A B.

To find the first point on the line A C, diminish the reading at A by $1\frac{1}{2}$ foot, and send the staff towards C, in like manner.

It is most convenient to mark the intersections of the Contours with one boundary line at a time: if the ground be falling along that line, after a point in a Contour is fixed, add the intended interval between the Contours to the reading on the staff at that point, and the place where it stands when the vane agrees with the horizontal wire of the telescope of the instrument will be a point in the next lower Contour; and so long as the staff will admit the addition of the interval, the successive Contours may be marked without moving the theodolite: this would be the method in proceeding along A B, from A to the level 200. If the ground be rising, choose a place for the instrument as much above the last point fixed as will bring the telescope nearly on a level with the vane when raised to its highest position, or with the top of a levelling staff without a vane; and then by continually deducting the interval, the intersections with the line of several Contours may be marked after each removal of the instrument: this would be the process from the level 200 to B.

The levels of the trigonometrical points check the above operation, and if after marking all the points along one of the boundary lines, it is found that the position of the last is incorrect with reference to the assigned level of the neighbouring trigonometrical point, the cause of the error should be ascertained, and the error corrected before proceeding further.

To trace the Contours between the points established upon the boundary lines, put up the instrument at some point easily fixed upon the trace, from which at least one end of the portion of contour to be traced can be seen, and neither too high, nor too low, to permit the staff being read when held upon the Contour. Send the staff to the visible extremity of the Contour, and read the level; move the staff in the direction of the Contour, and every point where the same reading is obtained, with the same position of the instrument, will be a point in it. When as many points have been

fixed as are necessary to trace the part of the Contour visible from the instrument, take the angle between the last point fixed and some point given in the trace, unless the situation of the last point is known by being close to some object given in the trace; lay down the direction of the line from the instrument to the last picket; chain the line, fixing the points of the Contour by offsets, as they are successively passed; and add the work to the trace as it proceeds.

Thus if the instrument be placed at *f*, its position may be fixed by measuring its distance from each of the pickets marked 260 and 270; the staff being read, or adjusted when held at 270, may be moved to *g*, *h*, *i*, and 270 (as a check) in the boundary line B C, the exact place for the picket at *g*, *h*, or *i*, being determined by moving the staff up or down the slope until the reading on the staff is the same as at 270 in the line A B.

With the same position of the instrument, if the staff be about 12 feet in length, the points *l*, *m*, *n*, in the Contour 265, and the points *o*, *p*, *q*, in the Contour 260, might be established, the staff being read, or adjusted at the picket 265, before it is sent along the former Contour, and at the picket 260, before it is moved along the latter; by measuring the line *f*, *k*, these points may be determined by offsets, and the Contours drawn upon the trace. From the same point also, all the pickets required to describe the Contours having the levels 260 and 265, and lying wholly within the triangle, may be fixed, since the telescope of the instrument would be higher than the summit they surround; and by measuring the line *f*, *t*, these Contours could be added to the trace.

It is not necessary to trace every Contour instrumentally: if the Contour 275 has been thus traced, the two between 275 and 260 can be added very correctly by the eye while the Contour 260 is being traced, by judging each time a picket of the latter is fixed upon the trace, how the intermediate interval should be divided to accord with the appearance of the ground.

Neither is it always necessary to fix the position of the instrument, for the pickets may often be surveyed without measuring from it; but wherever angles are used to set off the measured lines it is necessary, and may be considered the general rule.

A single position of the instrument will seldom trace a Contour,—fences, &c., as well as the form of the ground, preventing it. If the instrument were placed at *r*, to trace the level 255, the last picket would probably be at *s*, the angle between the corner of the house, H, and the picket, *s*, might be observed, protracted on the trace, the line measured, the several pickets as far as *s* added to the plan, the instrument removed to *s*, and the Contour completed.

But the instrument might, in the case represented, be placed near *s*, its position being fixed if necessary by measurement from any of the points recognized on the trace, as the angles of the adjacent fence; from this point the whole Contour could be traced, neither buildings, fences, nor other objects intervening.

If the triangle be very large, and the Contours inconveniently long, it may easily be divided, and a dividing line should, if possible, be chosen running along one of the ridges of the ground; for the ridges afford the best sites for the instrument in tracing; and the ridges and valleys are convenient situations for check lines, because those measured to survey the pickets having to change their direction in crossing them, can then be closed upon points already fixed. The line T V would be a good dividing line in the figure, running along the ridge on which the point *s* is marked, and fixing two points in each of the Contours of the summit within the triangle.

If it be required to contour a single feature of ground, not as part of a large survey, but for some particular object, run lines from the summit along the several ridges of the ground, fix upon these lines the points where the Contours will intersect them, and trace as above the Contours between them: if the number of check lines be too few, run them in the valleys also.

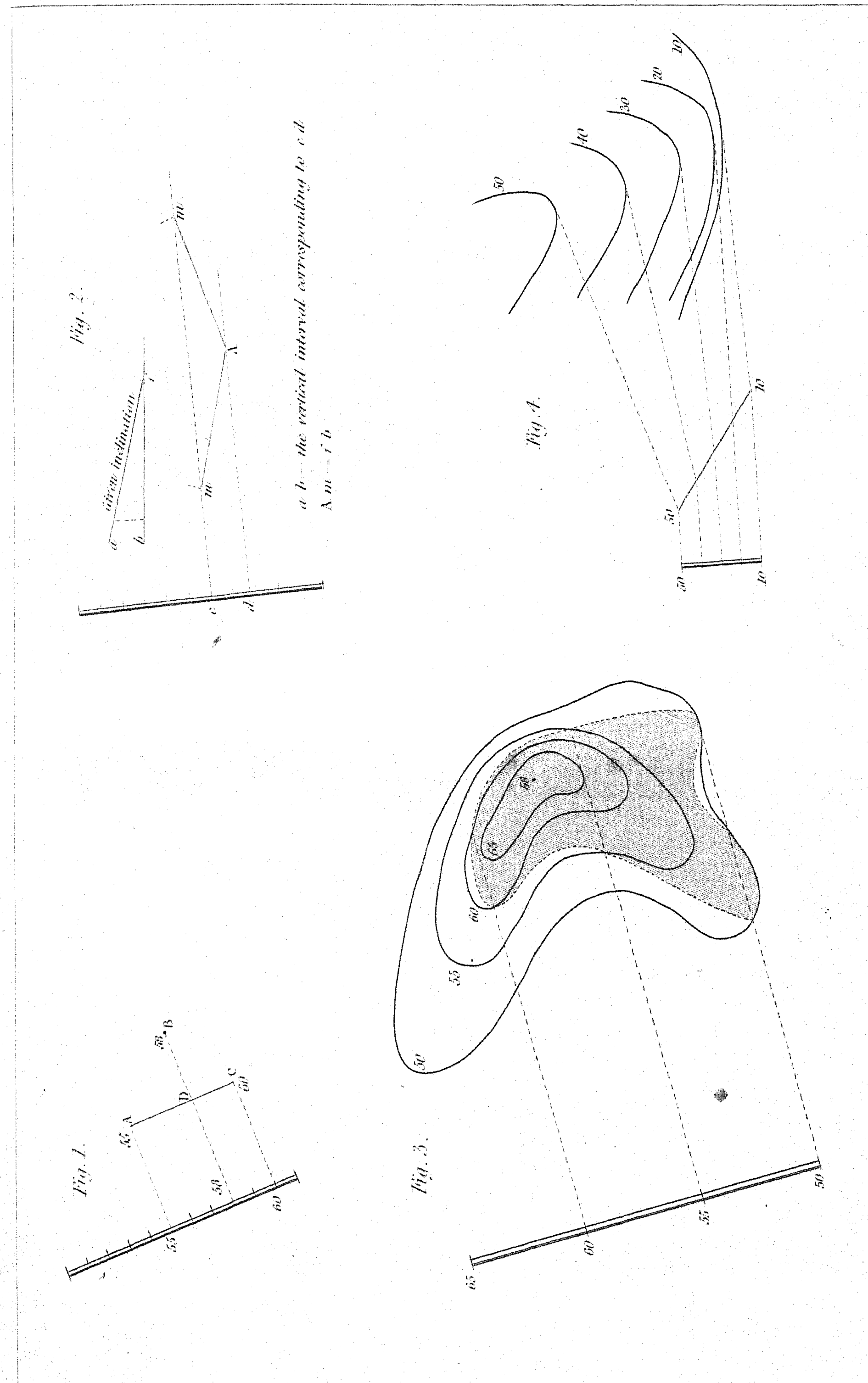
Fig. 1.
Fig. 2.
Given inclination
a b = the vertical interval corresponding to c d
Fig. 3.
Fig. 4.

J.W. Lowry fc.